104

S. Hrg. 104–185

HEARING ON THE WHITE HOUSE OFFICE OF SCIENCE AND TECHNOLOGY POLICY AND THE FISCAL YEAR 1996 BUDGET OF THE NATIONAL SCIENCE FOUNDATION

Y 4.C 73/7:S.HRG. 104-185

Hearing on the White House Office o...

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FOURTH CONGRESS

FIRST SESSION

MARCH 30, 1995

Printed for the use of the Committee on Commerce, Science, and Transportation

SUPERINTENDENT OF DOCUMENTS
DEPOSITORY
DEC 05 1995
BOSTON PUBLIC LIBRARY
GOVERNMENT DOCUMENTS DEPT

U.S. GOVERNMENT PRINTING OFFICE

39–788 CC WASHINGTON : 1995

For sale by the U.S. Government Printing Office
Superintendent of Documents, Congressional Sales Office, Washington, DC 20402
ISBN 0-16-047741-7

107

S. Hrg. 104–185

HEARING ON THE WHITE HOUSE OFFICE OF SCIENCE AND TECHNOLOGY POLICY AND THE FISCAL YEAR 1996 BUDGET OF THE NATIONAL SCIENCE FOUNDATION

Y 4. C 73/7: S. HRG. 104-185

Hearing on the White House Office o...

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FOURTH CONGRESS

FIRST SESSION

MARCH 30, 1995

Printed for the use of the Committee on Commerce, Science, and Transportation

SUPERINTENDENT OF DOCUMENTS
DEPOSITORY
DEC 05 1995
BOSTON PUBLIC LIBRARY
GOVERNMENT DOCUMENTS DEPT

U.S. GOVERNMENT PRINTING OFFICE

39–788 CC WASHINGTON : 1995

For sale by the U.S. Government Printing Office
Superintendent of Documents, Congressional Sales Office, Washington, DC 20402
ISBN 0-16-047741-7

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

LARRY PRESSLER, South Dakota, *Chairman*

BOB PACKWOOD, Oregon
TED STEVENS, Alaska
JOHN McCAIN, Arizona
CONRAD BURNS, Montana
SLADE GORTON, Washington
TRENT LOTT, Mississippi
KAY BAILEY HUTCHISON, Texas
OLYMPIA J. SNOWE, Maine
JOHN ASHCROFT, Missouri

ERNEST F. HOLLINGS, South Carolina
DANIEL K. INOUYE, Hawaii
WENDELL H. FORD, Kentucky
J. JAMES EXON, Nebraska
JOHN D. ROCKEFELLER IV, West Virginia
JOHN F. KERRY, Massachusetts
JOHN B. BREAUX, Louisiana
RICHARD H. BRYAN, Nevada
BYRON L. DORGAN, North Dakota

PATRIC G. LINK, *Chief of Staff*
KEVIN G. CURTIN, *Democratic Chief Counsel and Staff Director*

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

CONRAD BURNS, Montana, *Chairman*

LARRY PRESSLER, South Dakota
KAY BAILEY HUTCHISON, Texas
TED STEVENS, Alaska
TRENT LOTT, Mississippi

JOHN D. ROCKEFELLER IV, West Virginia
JOHN F. KERRY, Massachusetts
RICHARD H. BRYAN, Nevada
BYRON L. DORGAN, North Dakota

CONTENTS

List of Witnesses

Appendix

HEARING ON THE WHITE HOUSE OFFICE OF SCIENCE AND TECHNOLOGY POLICY AND THE FISCAL YEAR 1996 BUDGET OF THE NATIONAL SCIENCE FOUNDATION

THURSDAY, MARCH 30, 1995

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The committee met, pursuant to notice, at 10:04 a.m., in room SR–253, Russell Senate Office Building, Hon. Conrad Burns (chairman of the subcommittee) presiding.

Staff members assigned to this hearing: Louis C. Whitsett, staff counsel, and Timothy B. Kyger, professional staff member; and Patrick H. Windham, minority senior professional staff.

OPENING STATEMENT SENATOR BURNS

Senator BURNS. The committee of one will come to order. I am sorry to be a little late.

Thank you, Dr. Gibbons and Dr. Lane for your attendance here this morning. I have a statement; however, I am going to hold up on my statement until you can make yours. We have come to hear you more than we did me.

And we are very interested on what is happening in your world, and how that relates to this committee, and, of course, to this government and to the American people.

We have a vote coming up at 10:20 on the confirmation of

Mr. Glickman, the Secretary of Agriculture. So what we will do is we will take opening statements from Dr. Gibbons this morning and Dr. Lane.

And then we will have the vote, and then we will have some dialog, and we want to hear from our second panel.

So thank you, gentlemen, for coming this morning. We look forward to your statements.

Thank you, Dr. Gibbons.

STATEMENT OF HON. JOHN H. GIBBONS, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Dr. GIBBONS. Thank you, Mr. Chairman. We very much appreciate being with you this morning, and we understand the pace of life you are having to lead. So we will try to move right along.

Senator BURNS. For us overweight fellows, it is getting to be a crunch any more. [Laughter.]

Dr. GIBBONS. Well, we are here to speak about the administration's science and technology strategy, Mr. Chairman.

We think we all appreciate the fact that our mastery of science and technology is largely going to determine whether our citizens are able to capture new opportunities like better jobs and a higher quality of life, as well as to continue the basic amenities that we enjoy, that we have derived from advances in science and technology in the past.

We have had extraordinary progress over the last 50 years, and at least half of it, it is estimated, has come from advances in technology.

Our future can also be very eventful, just like the past half century, but we have to invest wisely and well in technology, if we expect to have a globally competitive private sector that is creating additional new high-wage jobs, and we can have educated citizens ready to take on those jobs.

But for society as a whole, the return on investments from the public sector is about 50 percent. That very high rate of return, which we can measure historically, is what we count on and why we feel so firmly that support of science and technology, both in terms of policies, as well as investments in the public sector, are very important.

We opt to choose for that continued strong investment in science and technology, because it has worked so well in the past, and it bears every promise of it working in the future.

The President's biannual report to Congress on the status of science and technology, we are pleased to release to the Committee today, Mr. Chairman. We hope that people will have a chance to review this. I think it is a compelling case for the President's position.

An example of the ways our investments in the past are paying off for us in the national information infrastructure and that superhighway I would be happy to talk with you about it later this morning after you return from the road, because we feel it is a perfect example of how public investment, coupled with private investment, and the right kinds of policies are enabling this country to capture that new technology in a way that most of the countries in the world have not been able to do.

I hope that we can repeat this success in information technology with successes in other areas. We will be prepared to talk about education, transportation, buildings, and construction, and other areas where technology is making such an enormous difference in our opportunities.

We have always, as a government, stepped up to the task of delivering science and technology to non-market areas such as national defense as well as to the task of encouraging development of technologies that are critical to economic growth and to the creation of good jobs.

For example, Federal investment in agricultural science and technology, as you well know, Mr. Chairman, has made it possible for our agricultural community to feed us and much of the rest of the world, and do it profitably.

Investments in aeronautics helped the U.S. companies capture global markets for aircraft and make air travel accessible to most Americans.

One can make the similar statements of great successes of these kinds of partnerships, whether it be electronics and computers, or space technology, or bio-medicine, or bio-technology.

We feel we simply cannot walk away from that responsibility to ensure similar advantages for future generations.

But we can, nonetheless, make our science and technology programs work better and cost less. The early pledge of this administration was not only to cut the deficit, but also focus on investments, such as science and technology, that can improve our opportunities for the future, and along with this, to improve the way we use the public's funds in carrying out the government's activities.

Out of that came the reinvention of government, which is occurring, the latest this week, on NASA's reinventions and the likes, and also the creation of the National Science and Technology Council, which is helping fit all these pieces of science and technology together into a more coherent whole than we have had before.

We are already acting, as I said, on this conviction of being able to do things better and more effectively, at least an example being NASA.

Now, that agency's 1950 style of infrastructure and its setting derived from the cold war is now being brought into the information age, at a likely savings of billions of dollars, and the savings also of thousands of government jobs.

Similar efforts and similar savings we believe are underway at the Federal Emergency Management Administration, FDA, the Department of Energy, the EPA, the Small Business Administration, and other agencies.

We are working through this in a way in which we hope to use careful analysis and a sharp scalpel to recreate these agency's just similar to the way the private sector has been doing for the past decade to make things work better.

Working with my good friend, Neal Lane, I will soon be briefing the Vice President on how changes in Federal requirements can reduce paperwork and administrative time and burdens on our professors and researchers in our universities and laboratories.

That way we hope to free up time for more research for scholarship and invent new things, and to teach the next generation of researchers and scholars, instead of taking so much time in doing paperwork.

Now, all of us need periodic reminders about the necessity to invest in the future, but this country has an excellent track record of using science and technology investments to do just that.

And if imitation is the sincerest form of flattery, then we ought to be flattered, indeed, by our global competitors.

While the U.S. still leads the world in total dollars spent on research and development, Japan and Germany, for example, now surpass our level of research spending as a percent of GDP, and are even further ahead of us in non-defense research spending, as a fraction of GDP.

Just a week ago we released a report on national critical technologies, Mr. Chairman, which points out that in 27 areas of technology, the U.S. leads. That's the good news.

But we are shrinking in that lead. Europe is now dead even or very close to us in 25 of those 27 areas. Japan is tied or very close to us in seventeen of those twenty-seven areas, and they are fast closing on five more.

So if we want to stay ahead, or even stay even, we have to keep making these investments or lose out.

Our competitors are becoming more and more like Aesop's Fable's ants, who through thick and thin always put a little bit aside for the cold and rainy days. We did that for ourselves.

But now, I fear, we may be becoming more like Aesop's grasshopper, who sang the summer away. In unison, and I think for good cause, we sing less government and lower taxes. But there is dissonance when we try to talk about preparing for the future, and putting aside a fair amount for our children and grandchildren.

I think we need to re-seek some of that harmony, Mr. Chairman and we are determined to do that, and we very much appreciate the interest and support of this committee in this approach to the future. Thank you, sir.

Senator BURNS. Thank you, Dr. Gibbons.

[The prepared statement of Dr. Gibbons follows:]

Testimony of the Honorable John H. Gibbons
Director, Office of Science and Technology Policy

before the

Subcommittee on Science, Space, and Technology
Committee on Commerce, Science, and Transportation
United States Senate

March 30, 1995

CLINTON ADMINISTRATION SCIENCE AND TECHNOLOGY STRATEGY

Mr. Chairman, members of the committee, thank you for inviting me here today to speak with you about the Clinton Administration's science and technology initiatives. These initiatives are an integral part of the President's New Covenant -- his pledge to reinvigorate middle class America.

We are now having a great debate about how we can best assure the American Dream for present generations and for those of the next century. The choices we make will have profound effects on our lives and those of our children and grandchildren.

In this historic era we have experienced the end of the Cold War, the dawn of the Information Age, a globalized economy, an explosion of entrepreneurialism. We have before us enormous opportunities. At the same time, we have profound challenges. We have experienced almost 20 years of stagnant incomes in the United States. We have growing inequality of incomes based primarily on educational differentials. We have challenges abroad in terrorism, environmental destruction, population explosion, and the proliferation of weapons of mass destruction.

Government has an important role to play as a partner in meeting the challenges of the future. The role of government is to increase opportunity as we shrink bureaucracy, to empower people to make the most of their own lives, and to enhance our security at home and abroad. We aim to expand the middle class and shrink the underclass. And we have to do it with a government that is smaller and less bureaucratic, but still effective.

The future is in our hands. We can have a globally competitive private sector that is creating new, high-wage jobs and educated citizens ready to take those jobs. Or we can have 20 more years of stagnant incomes and watch our industries lose ground in the race for global market share.

We choose prosperity, Mr. Chairman. Science and technology will help us cut the straightest path from here to there.

Why We Invest in Science and Technology

In his biennial report to the Congress, which we are releasing today, Mr. Chairman, the President reaffirms his belief that sustained investments in science and technology are absolutely essential to our knowledge-based society. Thoughtful investments in science and technology fuel economic growth, strengthen national security, and improve the quality of life. This Administration is focusing its science and technology resources on high priority areas, including:

- Economic growth and job creation
- Education and training
- Environmental quality
- Health
- Information technology
- National security
- World leadership and cooperation in science, mathematics and engineering

Success in each area will depend on advances in fundamental science, continuing technological innovations, and responsible governance.

Scientific knowledge is the key to the future. America's future demands an expanding knowledge base, which requires investment in our people, institutions, and ideas -- shared broadly with our global partners. Science lies at the heart of that investment -- it is an endless and sustainable resource with extraordinary dividends.

The public will receive a substantial return on this investment. While there is much room for uncertainty in measuring the impact of federal research spending, repeated studies suggest that the payoff to the Nation's economic welfare is great. The private rate of return on research and development spending -- meaning the return to the firm performing the research and development -- averages about 20 to 30 percent. But the social rate of return -- including spillovers to other firms and customers -- averages about 50 percent, or twice as high.

The nation's commitment to world leadership in science, engineering, and mathematics created the world's leading scientific enterprise, whether measured in terms of discoveries, citations, awards and prizes, advanced education, or contributions to industrial and informational innovation. Our scientific strength is a treasure we must sustain and build on for the future.

Technology is the engine of economic growth. Over the past 50 years, at least a quarter of U.S. economic growth -- possibly as much as half -- came from new technology built upon earlier fundamental discoveries. These advances created millions of good new jobs, a cleaner environment, better health and longer lives, new opportunities for individuals, and enrichment of our lives in ways we could not imagine half-a-century ago. For example:

- Early investments in ARPANet, the first national computer network, have brought us to the 25th anniversary of the Internet, a prototype of the Global Information Infrastructure. When it started out, ARPANet could transmit only 56,000 bits of data per second. Today networks using technology several generations more advanced routinely transmit 45 million bits a second -- almost a thousand times faster. The federal government provided a relatively small catalyst (a few tens of millions of dollars annually) that has been matched several times over by private-sector investment in the Internet. The federal government deliberately set out to commercialize and privatize the Internet. Today dozens of companies are investing millions of dollars and competing to provide Internet connections and new services to the tens of millions of Internet users around the world.

- Public investments in biomedical research spawned a multi-faceted biotechnology industry that already accounts for 100,000 jobs and $8 billion in annual sales. We owe extraordinary advances in agriculture and in chemical and pharmaceuticals processing -- as well as our ability to capture large markets in health care and other industries -- to fundamental research in molecular biology and applied research and development of advanced instrumentation funded by the U.S. government.

Our vision is of long-term economic growth that creates jobs while improving and sustaining the environment.

Responsible government advances science and technology. Government is an essential actor in making sure science and technology help the Nation reach its goals. Only the federal government can bring the benefits of science and technology to nonmarket areas, such as national defense, education and training, environmental quality, global health threats, or world-class fundamental scientific research.

A government role also is vital in promoting, in partnership with the private sector, those technologies critical to economic growth and to the creation of good jobs that cannot attract sufficient private investment. The U.S. government always has stepped up to this task. For example, federal investment in agricultural science and technology made it possible for our farmers to feed us and much of the world -- and do it profitably. Our investments in aeronautics helped U.S. companies capture global markets for aircraft and make air travel accessible to most Americans. We cannot walk away from our responsibility to ensure similar advantages are available to future generations.

A regulatory and economic environment favorable to capital formation and private-sector investment in research and development also is essential to advances in science and technology. To encourage private investment, the Administration has supported:

- extension of the research and experimentation tax credit;
- reduced capital gains taxes for small businesses;
- reduced antitrust barriers to the formation of joint production ventures;

- transfer to the private sector of a portion of the radio frequency spectrum previously used by federal agencies and competitive bidding on new licenses;
- liberalization of controls on the export of computers, telecommunications, and other technologically sophisticated equipment;
- bilateral and multilateral trade agreements that expand access to foreign markets for America's high-tech companies.

As with all aspects of governance, however, we must make our science and technology programs work better and cost less. We are already acting on this conviction, as you can see in the reinvention efforts at NASA. That agency's 1950's-style infrastructure will be brought into the information age -- at a likely savings of billions of dollars and thousands of government jobs.

We have made an excellent start on this effort on a government-wide basis with the National Science and Technology Council (NSTC). The NSTC is a virtual department -- a coalition of agencies that coordinate their efforts, divide tasks, and share resources to advance science and technology. This mechanism for direct communication between agencies cuts through bureaucracy and encourages the identification and coordinated pursuit of common goals and objectives.

The NSTC process led to a decision to converge the polar orbiting environmental satellite systems of the Departments of Defense and Commerce. This decision alone should save the American taxpayer several hundred million dollars by the turn of the century. Another Presidential Decision issued in 1994 directed continuation of the Landsat remote sensing satellite program and restructured federal agency responsibilities for acquiring and operating the next satellite (Landsat-7). That decision ensures the continuity and availability of the Landsat remote sensing capability which is used for civil, commercial and national security purposes. A third NSTC Presidential Decision articulated the new national space transportation policy and established clearly delineated roles and responsibilities for the principal agencies.

The NSTC is hard at work on science and technology initiatives designed to strengthen America's middle class. Our priorities include a healthy economy, global stability, and a cost-effective government. We have developed a conservative investment portfolio that balances the need for deficit reduction and immediate benefits for our citizens with the need to make long term investments in our country's future.

S&T Priorities in a Dynamic Economy

America's welfare hinges as never before on the way we manage the opportunities and the hazards of new concepts in science and technology. We have sustained our commitment to a strong fundamental science base and to science and technology in support of our national security strategy. We now recognize, however, that national security depends on a globally competitive economy that creates jobs and protects the environment as well as military

strength. And we intend to use science and technology to make government work better and cost less.

Commitment to Fundamental Science. Science provides an endless frontier of inquiry. Advancing that frontier feeds our sense of adventure and our passion for discovery. The unfolding secrets of nature provide new knowledge to address crucial challenges, often in unpredictable ways. These include improving human health, creating breakthrough technologies that lead to new industries and high quality jobs, meeting our national security needs, protecting and restoring the local, regional, and global environment, and feeding and providing energy for a growing population. Science is a critical investment in the national interest, and we have pledged to:

- maintain leadership across the frontiers of scientific knowledge;
- enhance connections between fundamental research and national goals, such as economic prosperity, national security, health, and environmental responsibility;
- stimulate partnerships that promote investments in fundamental science and engineering and effective use of physical, human, and financial resources;
- produce the finest scientists and engineers for the twenty-first century; and
- raise scientific and technological literacy of all Americans.

Commitment to National Security. Science and technology support the Administration's national security strategy in three important ways.

- Advances in science and technology ensure the technological superiority essential to maintaining our unparalleled military capabilities.
- A vibrant, dual-use high technology industrial sector enhances our national economic strength while also providing the technological base for advanced military capabilities.
- Technology is central to our efforts to: prevent and counter the proliferation of weapons of mass destruction and the means of their delivery; verify and monitor existing and prospective arms control agreements; and ensure the safety and reliability of our reduced nuclear weapons stockpile.

A strong domestic science base supporting a robust national security science and technology program is critical to preserving technological advantage. OSTP addressed this issue in the National Critical Technologies Report released last week. The report details the current competitive position of the United States relative to Japan and relative to Europe for each of 27 principal critical technology areas (from the broad areas of: 1) information and communications; 2) "living systems;" 3) environmental quality; 4) energy; 5) transportation; 6) manufacturing; and 7) materials). Overall the report shows the United States at parity with, or ahead of the positions of Europe and Japan in all areas. The report also shows, however, that the rate of progress is greater in Japan and Europe -- meaning our tenuous lead is shrinking in the midst of proposals to gut the core of our strategy to preserve American preeminence.

Our strategy to retain our lead in these critical technologies is to apply resources broadly at the basic research level and make further investment decisions as emerging technologies reveal the most promising payoff areas. Many of the technologies we need for advanced military capabilities are available in the commercial sector, and in some cases they are more advanced and cost less. We are working to enhance our relationship with private industry through partnerships that enable us to access and capitalize on those commercial technologies that offer the greatest military application. The long-term payoff will be better military capabilities at lower cost, and a strengthened economy.

Science and technology play key parts in our national strategy to stem the proliferation of weapons of mass destruction and their means of delivery. Verification and monitoring of compliance with arms control agreements is made possible by unique abilities provided by American basic and applied science in fields as diverse as chemistry, optics, and solid state physics. Technology also supports our policy goals of discouraging accumulation of weapons usable fissile materials, strengthening controls on those materials, and reducing global stocks. Science and technology also make vital contributions to the safe stewardship of our own nuclear weapons. We have structured a science-based stockpile stewardship program that will apply scientific understanding, predictive capability experiments, and simulation to ensure the safety, security, and reliability of our enduring nuclear stockpile.

Commitment to a Healthy Economy. Our Nation faces significant economic challenges. Markets are global, competition is fierce, technological change is swift and unabating. Meeting these challenges requires a strategy to equip American companies and workers to compete successfully in the 21st century economy. We have assigned high priority to developing the information infrastructure necessary to compete in the global economy, to enabling American manufacturers to produce globally competitive products that meet environmental goals, and to preparing the workforce for the high-wage, high-skill jobs of tomorrow.

- **Information Technology**. Our Nation leads the world in developing and applying information technology that is revolutionizing the way we live, learn, and work. Because of the strategic value of these technologies and their role in fostering economic growth, nations around the globe are investing heavily in the development and deployment of computer systems and telecommunications networks. Our vision for federal investment in information technology is to accelerate the evolution of existing technology and to nurture innovation that will enable its universal, accessible, and affordable application to enhance America's economic and national security in the 21st century.

  President Clinton and Vice President Gore have made development the National Information Infrastructure (NII) at top priority because they believe that access to advanced computing and communications technologies can dramatically improve the quality of life for every American. The NII will:

- Provide better access to health care.
- Make American workers more productive.
- Help our children learn.
- Make government more efficient.
- Create millions of new, high-paying jobs.
- Provide us all with instant access to a huge variety of information and entertainment.

As you and I have discussed, Mr. Chairman, the information highway is a great equalizer. One of my favorite cartoons shows two dogs in front of a computer, with one saying to the other, "On the Internet, nobody knows you're a dog." And it's true. The information age means that what you know and how hard you work count for a lot more than who you know and where you came from.

Rural states will compete more readily with urban states as the information age progresses if we take care to ensure equality of access. This committee has been a leader in telecommunications reform, and the Administration looks forward to continued cooperation on an issue essential to the health of America's middle class.

- **Manufacturing Technology**. The government is partnering with industry in a variety of industry-led research and development initiatives, including microelectronics, electronics manufacturing, aeronautics, and biotechnology. These initiatives combine goals of competitiveness and economic growth with public benefits of job creation, environmental protection, improved health and safety, and less dependence on foreign sources of energy. The Partnership for a New Generation of Vehicles (PNGV) is an example.

  PNGV is one of the federal government's premiere ventures into cooperative civilian technology development. In it, we are tackling a technological challenge as tough as putting a man on the moon -- that is, to develop within 10 years a car with three times the efficiency of today's automobiles with no sacrifice in cost, comfort, or safety. If the project succeeds, the payoff to the public will be huge in terms of less dependence on foreign oil and lower emissions of greenhouse gases. The project also holds the promise of an extremely attractive car for world markets in the 21st century and a thriving U.S. auto industry to produce them. The government (in this case, a consortium of seven federal agencies) and industry (the Big 3 automakers -- Ford, GM, and Chrysler -- and many suppliers of materials and equipment) are working closely on a cost-shared basis to break highly challenging technological bottlenecks where the benefits are at least as much societal as commercial. PNGV's research priorities are:

  - development of advanced manufacturing techniques that make it easier to get innovations into the marketplace quickly;

- use of new technologies for near-term improvements in auto efficiency, safety, and emissions; and
- research leading to production prototypes of vehicles, including such advanced technologies as fuel cells, ultracapacitors, and hybrid vehicle propulsion systems.

Over the life of this partnership, funding will be shared roughly equally between government and industry, with the government contributing a greater share to basic research and to technologically riskier projects, and industry putting up the greater share as practical results get closer.

- **Educational Technology**. The most important measure of success of this Administration will be its ability to make improvements in the lives of Americans. Few enterprises touch the lives of as many people as do those concerned with education and training. High-quality education and training benefit the individual whose knowledge and skills are upgraded, the business seeking a competitive edge, and the Nation in increasing overall productivity and competitiveness in the global marketplace. It is essential that all Americans have access to the education and training they need and that the teaching and learning enterprise itself becomes a high-performance activity that is interesting and challenging to the participants.

  The President has placed a high priority on upgrading the technology available in our schools and businesses, in order to improve education and training. The Administration recently announced a national program to help communities around the country incorporate new educational technologies into their schools. He has also directed that advanced information technologies developed by the Defense Department that could be used for education and training be transferred to the Departments of Education and Labor for civilian use. Unfortunately some rescission proposals hit educational technologies especially hard, particularly the Star School program and the Technology Learning Challenge.

Commitment to Efficient, Cost-Effective Government. Science and technology can help this government serve its citizens better. One of the most important areas in which S&T can contribute is in regulatory decisionmaking, and we will be briefing the Vice President shortly on ways that regulatory reform can help produce a more conducive environment for the conduct of business, research, and education. While we must not retreat from our commitments to ensure the wellbeing of every American, policies to address risks to public health, safety, and the environment must be fair, effective, and affordable. The Administration has taken several steps to advance risk analysis, a key linkage between science and policy, including establishing the following priorities for investigation:

- *Uncertainty analyses and risk characterization*: research on methods for improvement of risk characterization and transfer of scientific information about risks, and the uncertainties in the information, to decision makers.

- *Criteria and indicators for ecosystem health:* research to identify criteria and indicators for risks to ecological health and sustainability.
- *Human and ecological exposure:* research on chemical, physical, and biological stressors, particularly for mixtures, multiple and/or cumulative exposures, and alternative pathways of exposure.
- *Mechanisms of disease & ecological impacts:* research to identify and predict the magnitudes of new ecological risks and noncancer human health effects and to understand better the biological effects of carcinogens at very low doses.

The Administration is working within and across agencies to improve the methods by which risks are evaluated and the ways in which the resulting information is integrated with economic, social, and other considerations in making decisions that will ensure the appropriate and effective protection of public health, safety, and the environment.

These examples of the Administration's S&T priorities illustrate the critical roles science and technology play in our society. We have produced a science and technology program that, within the spending limits established by the new covenant with America, ensures a better world for our children and their children. We have integrated federal science and technology programs with efforts in the private sector and internationally in order to maintain a strong, vibrant, sustainable economy.

Are We Ants or Grasshoppers?

Mr. Chairman, all of us need periodic reminders about the necessity to invest for the future, but this country has an excellent track record of using science and technology investments to do just that. Our global competitors in defense, aeronautics, medical devices, pharmaceuticals, and computers have learned from our example. They now make similar or greater investments.

The charts attached to this statement provide some R&D spending data shown in terms of investment as a percentage of GDP, which helps us compare nations. This is similar to comparing IBM with much smaller companies. IBM invests in R&D as a percent of sales to support a big business. Small companies also invest a similar percent of sales in research and development.

The United States supports an almost $6 billion economy. On the other hand, Japan had a $2.5 billion economy in 1993.

As you can see from the charts, the U.S. still leads the world in total dollars spent on research and development. However, Germany and Japan equal or surpass our level of spending as a percent of GDP. As you can also see, they are far ahead of us in nondefense R&D spending.

Our competitors are becoming more and more like Aesop's fabled Ants, who put aside some seed corn for a cold, rainy day. We did that ourselves for many years. The federal government saw opportunities to invest in a better future, persevered in those investments, and reaped ample reward: For example:

- Fiber optics was a germ of an idea in an obscure area of basic physics in 1966 but now carry most U.S. long-distance telecommunications.
- The Global Positioning System represents a confluence of basic research in physics, software, communications, and high-speed electronics. First developed for military purposes, it is now rapidly expanding into commercial markets for navigation and air safety and monitoring Earth's large scale ecosystems.
- Severe weather prediction emerged from the integration of space platforms, immense computing power, and continued atmospheric science research to help prevent loss of life and property.
- DNA testing resulted from decades of basic research in molecular biology and computer science and now provides a way to identify people in the best of times -- for example, reuniting families after the civil unrest in Argentina -- and in the worst of times -- for example, associating suspects with crimes.

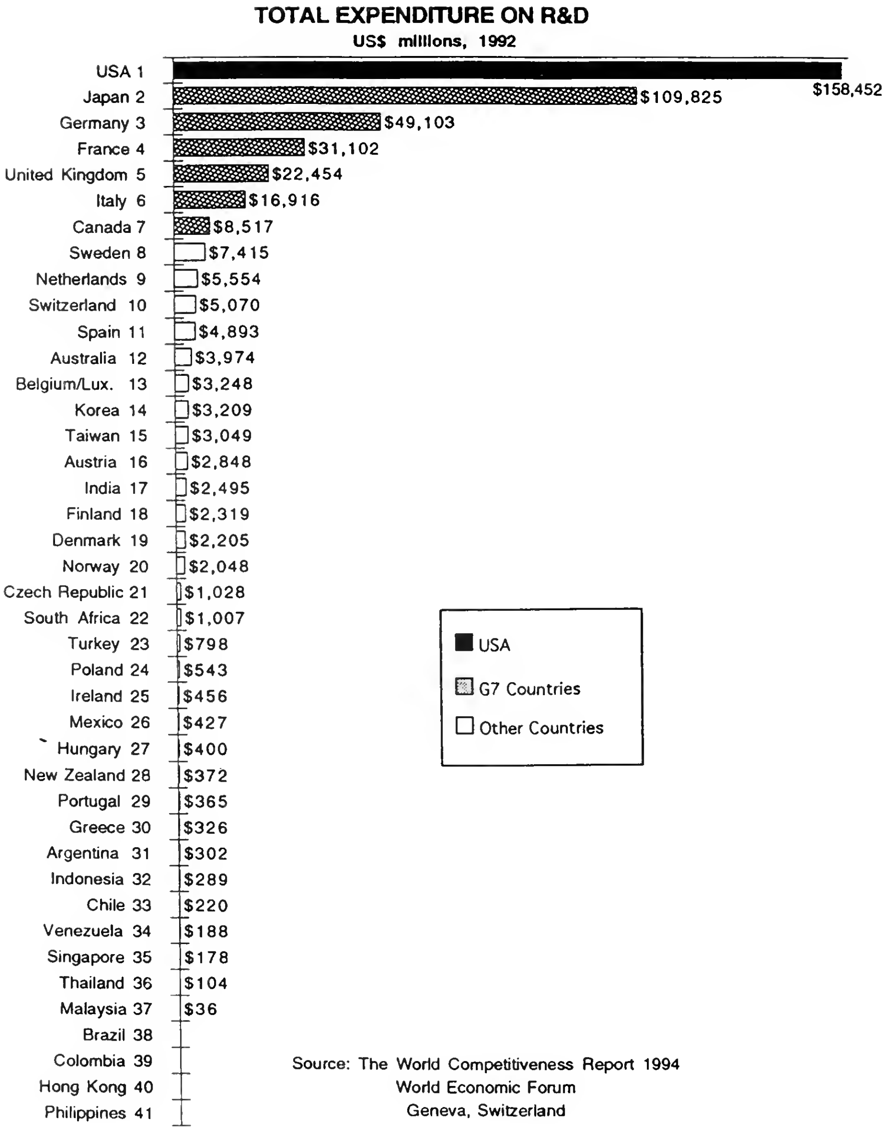
But I fear we may become like Aesop's Grasshopper, who sang the Summer away. In unison we sing "less government, lower taxes," but there's dissonance when we try to talk about preparing for the future, about putting something aside for our children and grandchildren. We must find some harmony, Mr. Chairman.

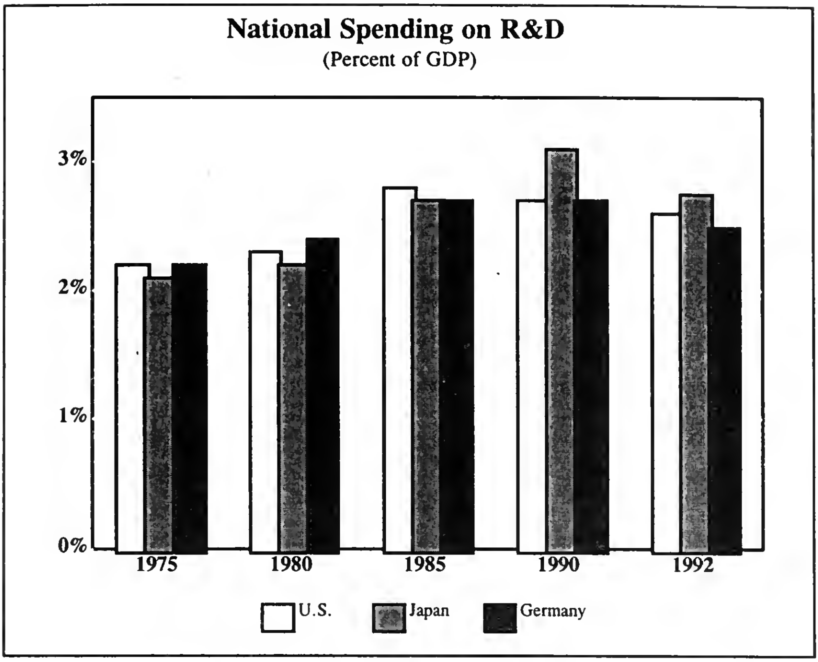
Scientific knowledge is the key to the future. Technology is the engine of economic growth. Together, science and technology build new businesses, provide good jobs, improve health and the quality of education, and protect us from threats as diverse as environmental degradation and military force.

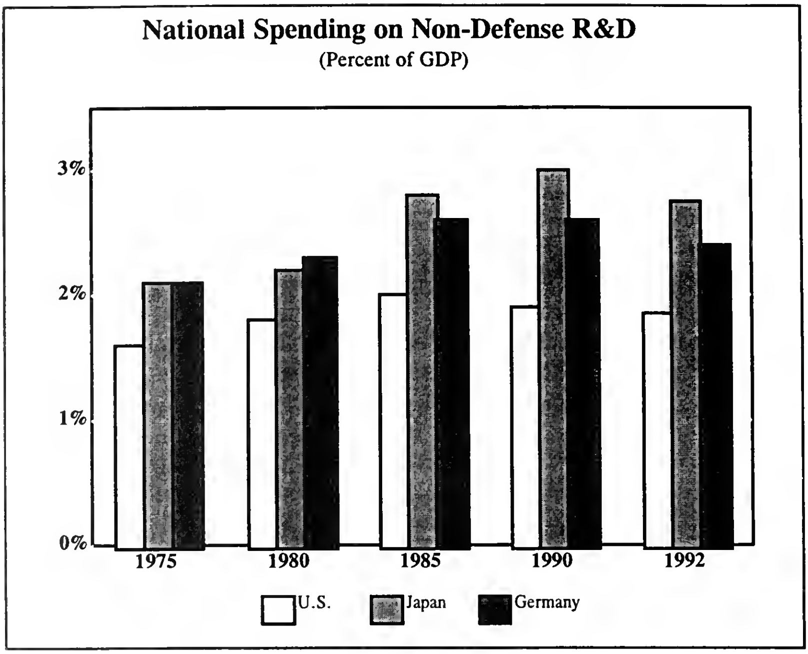
American mastery of science and technology will largely determine whether our citizens capture new opportunities -- good jobs, a higher quality of life -- and continue to enjoy basic amenities, including safe and affordable food and shelter. Innovations in myriad products and processes Americans count on for a better life, such as heart surgery, computing, and electric lighting, stem from scientific advances. The investments we make today in basic and applied research will assure the continuous flow of knowledge needed to develop new technologies for the future.

The federal government plays a crucial role in ensuring American leadership in science and technology. The Nation's world leadership in science, mathematics, and engineering fundamentally derives from federal sponsorship. Federal research investments led directly to the technological leadership of U.S. firms in agriculture, aeronautics, semiconductors, computers, communications, pharmaceuticals, and scores of other critical areas.

We remain convinced that: 1) the Nation's future depends on advances in science and technology; and 2) federal investment in research and development is an essential catalyst for such advances. The Administration is determined to continue investments in the future despite fiscal pressures today. We want to work with you in achieving this objective.


TOTAL EXPENDITURE ON R&D
US$ millions, 1992
USA 1
$158,452
Japan 2
$109,825
Germany 3
$49,103
France 4
$31,102
United Kingdom 5
$22,454
Italy 6
$16,916
Canada 7
$8,517
Sweden 8
$7,415
Netherlands 9
$5,554
Switzerland 10
$5,070
Spain 11
$4,893
Australia 12
$3,974
Belgium/Lux. 13
$3,248
Korea 14
$3,209
Taiwan 15
$3,049
Austria 16
$2,848
India 17
$2,495
Finland 18
$2,319
Denmark 19
$2,205
Norway 20
$2,048
Czech Republic 21
$1,028
South Africa 22
$1,007
Turkey 23
$798
Poland 24
$543
Ireland 25
$456
Mexico 26
$427
Hungary 27
$400
New Zealand 28
$372
Portugal 29
$365
Greece 30
$326
Argentina 31
$302
Indonesia 32
$289
Chile 33
$220
Venezuela 34
$188
Singapore 35
$178
Thailand 36
$104
Malaysia 37
$36
Brazil 38
Colombia 39
Hong Kong 40
Philippines 41
USA
G7 Countries
Other Countries
Source: The World Competitiveness Report 1994
World Economic Forum
Geneva, Switzerland


National Spending on R&D
(Percent of GDP)
3%
2%
1%
0%
1975
1980
1985
1990
1992
U.S.
Japan
Germany


National Spending on Non-Defense R&D
(Percent of GDP)
3%
2%
1%
0%
1975
1980
1985
1990
1992
U.S.
Japan
Germany

Senator BURNS. Dr. Lane, and thank you for coming this morning.

STATEMENT OF NEAL F. LANE, DIRECTOR, NATIONAL SCIENCE FOUNDATION

Dr. LANE. Thank you, Mr. Chairman, Senator Rockefeller.

I very much appreciate the opportunity to appear before you today to discuss the National Science Foundation's budget proposals for fiscal year 1996, and our role for preparing America for the new millennium and beyond.

With your permission, I will briefly summarize my testimony and my remarks.

Senator BURNS. By the way, both of your prepared statements will be entered into the record.

Dr. LANE. Thank you, Mr. Chairman.

The NSF was established in 1950, 5 years after the close of the Second World War. So just 5 years from now,

NSF will turn 50. So as a grandfather, and a bit older than 50, NSF seems a quite young institution, certainly a young institution in spirit and promise.

As all of you know, the creation of the NSF in 1950 was largely the result of the public realization of the value of research and development in achieving national objectives.

The NSF was charged with fostering first-rate fundamental research throughout the Nation and promoting education and training in science and engineering.

There is a general consensus among economists and policy researchers that public investments in science and engineering yield very high annual rates of return to society, as Dr. Gibbons had indicated.

The activities supported by NSF, mainly fundamental research and education, based at academic institutions, are generally viewed as among the most productive of all Federal investments.

To take an example recently in the news, NSF-sponsored research on gain theory and mathematical economics research has generated a set of rules for simultaneous multiple-round option that maximizes the value of bids for public goods.

This technique was recently used by the FCC to auction licenses for the radio spectrum. The bids were more than 30 percent higher than those anticipated, using the traditional option techniques.

Confidence and a high rate of return on investments and research underlies the administration's budget request for the NSF, a request for $3.36 billion in 1996. This is an increase of 3 percent over 1995, and a very good budget in these tough times.

Our budget request is guided in philosophy and principle by our recently completed strategic plan, entitled "NSF in a Changing World."

The plan sets three long-range goals for NSF, which I will abbreviate as world leadership, knowledge in service to society, and excellence in education at all levels.

Let me highlight each very briefly. World leadership in scientific research and learning does not naively assume that only America has top-notch scientists. Rather, it is a goal to articulate the need of our nation to be on the cutting edge in all-important fields.

We cannot expect to win all the Nobel prizes, but we should win many, and we should aspire always to be a major player in all fields, because you never know where the discoveries will occur.

The second goal, scientific knowledge in service to society, recognizes that we live in a world powered by science and technology; thus, we cannot afford to hold science separate and autonomous from our daily lives.

Our nation, indeed, every society has real needs and real problems, and science must toil in those trenches as a partner in finding solutions.

Progress toward these first two goals, world leadership and knowledge in service to society, presents us with the third goal, excellence in education at all levels for a technologically literate society.

Science education in our schools should strive to make students not only science conversant, but also science participatory. Within this framework, I would like to describe briefly how we carry out some of our research and education activities.

As you know, NSF is the principal source of Federal support for fundamental research in America's academic institutions in the science and engineering disciplines, excluding biomedical science, where NIH, of course, has the lead.

For example, we support over half of the research in computer science conducted at our academic institutions. We also support over half of the research in mathematics, and nearly half of the non-medical life science research.

We fund the best ideas from the most qualified people, as judged by their peers, who are experts in the fields.

Approximately two-thirds of the Foundation's total research support is designated for individual investigators and small-group research projects.

There are numerous examples of research that is assuredly fundamental that simultaneously holds promise to address very current problems.

The study of one of nature's greatest feats of engineering, the spider web, may seem to be esoteric and fundamental; however, researchers have determined that the silk spun by the golden orb-weaving spider possesses the strength of steel fibers while also being stretchable.

The process by which the spider spins silk, unlikely as it may seem, holds promise for yielding environmentally benign manufacturing techniques for industrial fibers. This research spans the fields of biotechnology, materials, and manufacturing.

Today, the Foundation has many diverse mechanisms for supporting research and education, always with the objective to create connections.

In addition to our emphasis on individual investigators, our broad portfolio of mechanisms includes Industry-University Cooperative Research Centers, Engineering Research Centers, Science and Technology Centers, Minority Research Centers of Excellence, and Long-Term Ecological Research Sites, to name only a few.

NSF also supports the construction and operation of a number of highly specialized national research facilities, such as the GEMINI telescopes, the Laser Interferometer Gravitational Wave Observ-

atory, which we call LIGO, the Cornell Electron Storage Ring, and the Cornell High Energy Syncrotron Source, a fleet of academic research vessels and a network of astronomy observatories, soon to be joined by the GEMINI telescopes.

In recent years, the NSF portfolio has evolved even further, by emphasizing the special perspective and advantages of interdisciplinary fundamental research and education. One mechanism for accomplishing this multi-faceted approach is by identifying areas of national needs, sometimes called strategic areas.

Our directorates give straightforward focused attention to maintaining the health of science and engineering disciplines, chemistry, biology, economics, and so forth. However, thinking of research and education in only disciplinary ways leads to a separation that in the real world of science and engineering simply does not exist.

So by defining interdisciplinary areas, such as environmental and global change research, research on materials or biotechnology, we are able to underscore the fact that in nature, science and engineering is integrated and interwoven.

That is the way the world really works. So this approach gives a panoramic vision to see and help solve some of the problems society is facing.

As I mentioned earlier, the NSF is one of the few principal Federal agencies tasked with improving science and math education for all students, K through 12, at the undergraduate level, and, of course, at the graduate level.

Our most recent initiatives are designed to create system-wide reforms at state, city, and regional levels. But we deliberately have adopted a systemic approach to avoid fragmented changes within a single subject matter or individual school.

These programs primarily come under our directorate for education and human resources, but also include activities in other directorates as well.

Within the 10-year period, from 1986 to 1996, the Education and Human Resources Directorate has received steady and rapidly increasing funding. The budget in 1987 was just over $100 million, and in 1995, it is roughly $600 million. The current figure is approximately one-fifth of the Foundation's budget.

Before concluding my testimony, I would like to mention very briefly the Foundation's efforts at management and performance. We are working hard to implement the Government Performance and Results Act.

It requires us to develop a strategic plan, which we are doing; have, in fact, published one such version. In addition, we are required to devise methods for measuring performance toward goals.

Measuring performance is nothing new for NSF. We have applied merit review with peer evaluation to everything that we have been doing in the areas of research and education, but reviewing how well we do that job is a real challenge, and we are looking for new ways to do that.

This time of change is exhilarating for the National Science Foundation. We believe we have a clear-cut vision of where we need to go and an orderly path to pursue, and we are confident of the goals that we set, and are willing to let them take us into un-

chartered territory, because, in our view, that is where the new opportunities lie.

That concludes our oral remarks, Mr. Chairman. Thank you very much.

Senator BURNS. Thank you, Dr. Lane.

[The prepared statement of Dr. Lane follows:]

REMARKS BY

DR. NEAL LANE

DIRECTOR, NATIONAL SCIENCE FOUNDATION

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

UNITED STATES SENATE

MARCH 30, 1995

***

Chairman Burns and Senator Rockefeller, I very much appreciate the opportunity to appear before you today to discuss the reauthorization of the National Science Foundation, our budget proposals for fiscal year 1996, and our role in preparing America for the new millennium and beyond. This subcommittee has consistently and generously supported the activities of the National Science Foundation and for that, I want to express my heartfelt appreciation.

We have recently submitted our draft authorization bill to the Committee. The draft bill contains an authorization proposal that is consistent with our budget request and a number of technical amendments to our organic act that would help improve the Foundation's operations. We look forward to working with the Committee toward its enactment.

A CONTEXT FOR THE NATIONAL SCIENCE FOUNDATION

I hope that my testimony today will elucidate both the philosophy and the value of the activities of the National Science Foundation to the nation. The NSF was established in 1950, 5 years after the close of the Second World War. At the turn of this century, in the year 2000, just five years from now, the NSF will turn 50. As someone who is a bit older than 50 and a grandfather, the NSF seems to me quite a young institution. It is certainly young in spirit.

Nevertheless, in its short institutional life, the NSF has played a critical role in helping America establish preeminence in science. Today, the NSF has an important responsibility for safeguarding and enhancing the nation's scientific future.

There is general consensus among economists and policy researchers that public investments in science and engineering yield very high annual rates of return to society (i.e., well over 20 percent). At a recent conference conducted jointly by the American Enterprise Institute and the Brookings Institution, many top researchers, including former Council of Economic Advisers Chairs Michael Boskin and Charles Schultze, agreed that research and development have a significant and important positive effect on economic growth and living standards. Furthermore, the activities supported by the NSF -- namely fundamental research and education based at academic institutions -- are generally viewed as among the most productive of all federal investments.

Mr. Chairman, we are the only federal agency mandated to promote the health of science and engineering generally across all disciplines. We take that responsibility very seriously.

The noted historian, Jacob Bronowski, wrote in his seminal work, The Ascent of Man, (quote) "The world today is made, it is powered by science." (end quote) It was the deliberate application of science to technology on a broad scale, stimulated by World War II and the post-war years, that led policy makers as well as scholars to recognize science as a powerful tool in the development of society.

This is not to say that science was irrelevant to the intellectual, industrial, or cultural life of civilization previously. The science curve began several millennia before the birth of Christ. And we all learned in school about the great achievements of the Greeks in advancing scientific thought. It is clear, however, that the war and the broad technological expansion after the war placed science in a new and central role in our society, fueling economic development and improving health and well-being.

As all of you know, the creation of the NSF in 1950 was largely the result of public realization of this new value of research and development in achieving national objectives. The NSF was charged with fostering first-rate fundamental research throughout the nation, and promoting education and training in science and engineering.

A dramatic turning point for the NSF and the nation occurred in 1957 with the Soviet launch of Sputnik. Suddenly, America felt an impending threat of Soviet supremacy in science and technology. Sputnik moved the NSF's mission into more aggressive focus with a national call for improving scientific education and expanding scientific research. To put this change into graphic relief, the very first appropriation for the NSF, in 1951, was $225,000. By 1966, that funding figure had grown to $480 million. Our programs had grown from the initial, small individual project grants and fellowships to a diversity of grants, contracts, fellowships, traineeships, national research programs, information resources, and data collection and analysis.

The NSF has continued to grow and evolve, in keeping with the expanding role of science in promoting economic and social progress. Our national goals, including business and commerce, have become dependent on ever more sophisticated science and technology. Science and technology have become increasingly intertwined, each benefiting from the other in complex ways. Universities, industry, and government have learned the advantages of collaboration and partnership.

NSF'S INVESTMENT STRATEGY

Today, the Administration's request for FY 1996 for the NSF is $3.36 billion. A summary of our fiscal year 1996 budget request by appropriation account is included at the end of this statement.

Our budget request is guided in philosophy and principle by our recently completed Strategic Plan, entitled, *NSF in a Changing World.*

The Plan sets three long-range goals for the NSF which I will abbreviate as:

- -- world leadership
- -- knowledge in service to society
- -- achieving excellence in education at all levels

Let me highlight each for a moment. World leadership in scientific research and learning does not naively assume that only America has top-notch scientists. Rather, it is a goal to articulate the need for our nation to be on the cutting-edge, the frontier, in all important fields. We cannot expect to win all the Nobel prizes, but we should win many. And we should aspire always to be a major player in all fields because you never know where the discoveries will occur. Striving to

attain this goal will help protect the broadest range of options for our economic and national security.

The second goal, scientific knowledge in service to society recognizes that science is integral to life on this planet, a world very much predicated on and powered by science and technology. Thus we cannot afford to hold science separate and autonomous from our daily lives. Our nation, indeed every society, has real needs and problems. Science must toil in those trenches as a partner in finding solutions.

Progress toward these first two goals -- world leadership, and knowledge in service to society -- presents us with the third goal, excellence in education at all levels for a technologically literate society. Science education in our schools should strive to make students not only science conversant, but also science participatory. If there is any sure-fire way to *integrate science into society* it is to build science confidence in young people through their own experimentation, analysis, and questioning.

Mr. Chairman, our strategic plan is an important mechanism for translating the Foundation's vision for the future into clear-cut objectives. Each of our individual activities must move us toward the accomplishment of one of the three goals. We view them as compass headings that will keep us on course.

Within this framework, I would like to elaborate on how we carry out some of our research and education activities.

SUPPORT FOR RESEARCH AND EDUCATION

As you well know, NSF is the principal source of federal support for fundamental research at America's academic institutions in the science and engineering disciplines (excluding biomedical science where NIH has the lead). For example, we support 56 percent of the research in computer science conducted at our academic institutions, and 43 percent of the non-medical life science research.

Approximately two thirds of the Foundation's total research support is designated for individual investigators or small group research projects. We fund the best ideas from the most qualified people --as judged by their peers, experts in the field -- while nurturing future generations of scientists and engineers. It is important to appreciate that in carrying out this role, the NSF helps support the underlying research enterprise that the various Federal agencies and private industry depend upon to accomplish their objectives.

It is also critical for all of us to recognize that although fundamental research, by its very nature, is focused on the unanswered questions that defy our ability to predict outcomes, that research is often initiated or influenced by a current, practical problem. The historical example of the French scientist Pasteur is often used to illustrate this point. Pasteur responded to public health and commercial goals throughout his stellar career in microbiology. Both the historical record and the current record substantiate the elegant interdependence in research of the quest for new knowledge and pragmatic purposes.

There are numerous contemporary examples of research that is assuredly fundamental but simultaneously holds promise to address very current problems. The study of one of nature's greatest feats of engineering, the spider web, may seem to be esoteric and fundamental. However, researchers have determined that the silk spun by the golden orb-weaving spider possesses the strength of steel fibers while also being stretchable. The process by which a spider spins silk, unlikely as it may seem, holds promise of yielding environmentally-benign

manufacturing techniques for industrial fibers. This research spans the fields of biotechnology, materials, and manufacturing.

Thus, when the NSF funds an investigator at an academic institution, this support does not in any way imply that his or her particular research is mutually exclusive of addressing some national need or goal. On the contrary, the distinctions that we make between basic and applied research with our words and definitions often do not exist in the world of science and engineering.

It is clear that all federally supported researchers want to be doing important work. Many things go into their determination of what is important, including knowledge of the frontiers of their fields and an awareness of how their work might be used.

A BALANCED PORTFOLIO

Today, the Foundation has many diverse mechanisms for supporting research and education, always with the objective to create connections. Each mechanism, in its own way, is designed to encourage flexibility and to capitalize on the advantages of combining research and education, which is a unique characteristic of the U.S. research system. Our broad portfolio of mechanisms includes individual investigators, small groups, Industry-University Cooperative Research Centers, Engineering Research Centers, Science and Technology Centers, Minority Research Centers of Excellence, and Long Term Ecological Research sites to name a few.

In addition, the NSF supports the construction and operation of a number of unique and highly specialized national research facilities such as the GEMINI telescope, the Laser Interferometer Gravitational Wave Observatory (LIGO), the Cornell Electron Storage Ring/ Cornell High Energy Synchrotron Source, a fleet of academic research vessels, and a network of astronomy centers.

These centers and national facilities are designed to address an identified need in a flexible and comprehensive institutional setting. The goal is always to bring a creative combination of resources and personnel to bear on a problem.

The various NSF research centers and national facilities, along with the long established individual investigator awards, reflect the flexibility of our research support mechanisms. In recent years, the NSF's portfolio has evolved even further by emphasizing the special perspective and advantages of interdisciplinary fundamental research and education. One mechanism for accomplishing this multifaceted approach is by identifying areas of national need, sometimes called "strategic" areas.

These build on our traditional Directorates and have strengthened the flexibility of our research and education support mechanisms to meet the changing needs of our economy, and the society in general.

Let me take a moment to explain why NSF has focused on research and education in these areas, in addition to our traditional emphasis on the discipline-based Directorates.

In our FY 1996 budget request, we have identified seven interdisciplinary areas:

Advanced Materials and Processing research
Biotechnology research
Civil Infrastructure Systems research
Environment and Global Change research
High Performance Computing and Communications research
Manufacturing Science and Engineering research, and
Science, Math, Engineering, and Technology Education

These areas extend across the directorate structure of the NSF, which tracks with traditional disciplinary lines. For example, we have a directorate for mathematical and physical sciences, one for biological sciences, one for geosciences, and so on. Cross-cutting areas provide a way to support fundamental research and education that requires participation of more than one discipline.

Our Directorates at the NSF allow us to give straightforward, focused attention to maintaining the health of our science and engineering disciplines. Unless we advance knowledge in the disciplines, we will not be able to address complex issues along multi-disciplinary lines. On the other hand, thinking of research and education in only disciplinary ways leads to a separation that, in the real world of science and engineering, does not exist. With only the structure of the Directorates, we lose the opportunity to glimpse the territories between them and the invisible connections that bind them.

By using interdisciplinary areas, we are able to understand and explore the world of science and engineering as integrated and interwoven -- the way in which it really works. This gives us the panoramic opportunities to see and solve problems in cross-cutting approaches.

EDUCATION AND HUMAN RESOURCES

As I mentioned earlier, the NSF was established with two primary missions -- to insure the best research in science and engineering, and to promote excellence in science, engineering, and mathematics education. We are, in fact, a principal federal institution tasked with improving science and math education for all students, both K-12 and at the undergraduate level, and of course at the graduate level. By building strong science, engineering, and math skills for all students throughout their school careers, we assure the nation a technologically literate 21st century workforce to compete in the global marketplace.

We have introduced new approaches to improving mathematics, science, engineering, and technology education. Our most recent initiatives are designed to create system-wide reforms at state, city, and regional levels. We deliberately have adopted a systemic procedure to avoid fragmented changes within a single subject matter or an individual school.

Our goal is to create an arc of change within which educators teach and students grasp the process and perspective of scientific thinking. It is, after all, not the accumulation of facts that we are striving for but rather the acuity of judgment, analysis, and problem-solving that is our ultimate educational objective.

In recognition of the different educational environments that exist within our vast nation, we have not proclaimed that one systemic arrangement "fits all." We have state-wide, urban, and rural systemic initiatives to accommodate the unique and variable environments in which education takes place across the country.

These programs primarily come under our Directorate for Education and Human Resources (EHR). Within the 10 year period from 1986 - 1996, the Education and Human Resources Directorate has received steady and rapid funding increases. The budget in 1987 was just over $100 million; in 1995 it is roughly $600 million. The current figure is approximately one-fifth of the Foundation's total budget.

The increased investment we have received for EHR programs over the last 10 years has allowed us to develop many new and experimental programs. After a period of rapid growth in any program, there is a concomitantly important time for examination and evaluation. We need to identify strengths and weaknesses in the programs in order to make improvements.

Now is the time to husband further resources for these programs and harness our best judgment to scrutinize them. That is why you will see a distinct funding plateau for this year's request. Actually, there is a slight decline. This should not be interpreted as a sudden lack of interest or priority in our commitment to science and math education. I hope you will recognize this trend as wisdom and watchfulness.

Our goal is to assure that every child is prepared to take science and math understanding and skills from school into life, into the workplace, into the community, and into their personal portfolios for success.

As an economically prosperous and competitive nation, we cannot afford to lose a single child's contribution. As a compassionate nation, we cannot neglect a single child's opportunity to learn and to live up to his or her highest potential.

Mr. Chairman, the federal government cannot teach a single child but we can help make it possible for every child to learn. We can leverage resources and promote reform. We can share responsibility and we can offer opportunity. The NSF is committed to being a steadfast partner with the states, the cities, parents, teachers, administrators, students and citizens to accomplish this task.

LINKING DISCOVERY AND LEARNING

Although we have a separate Directorate for Education and Human Resources, we at the Foundation recognize that virtually every NSF program is, by its very nature, an educational program as well. We must be even more alert to the myriad opportunities for capitalizing on the natural connections between the process of education and that of discovery.

In a similar vein, we must be more aggressive and creative to portray training in science as useful preparation for a broad array of professional careers. The study of science teaches us the path of critical thinking -- a vehicle for informed judgment. We live in a world where informed judgment seems to be in short supply.

I believe we should be encouraging our students to broaden their understanding and expectations of the diverse usefulness of their knowledge. After all, the study of science and engineering undergirds the fundamental elements on which much of contemporary society is built. The study of science and engineering arms students with the knowledge and skills to be captains of industry, leaders in government, editors of newspapers, film producers, or stock brokers to name a few possibilities.

If Jacob Bronowski was right about the world being powered by science, and I think he was, then the usefulness of research training is limited only by a person's imagination, not by the society in which he or she lives. Those in government and in the universities have a responsibility to articulate this philosophy. After all, we are partly at fault for defining science and engineering as esoteric and separate, when in fact it is universal and pervasive.

CONCLUSION

In concluding my testimony, I would like to mention briefly the Foundation's efforts at measuring performance. The Government Performance and Results Act of 1993 requires each federal agency to develop a strategic plan that describes the agency's goals. In addition, we are required to devise methods of measuring our performance toward those goals.

At the same time, as part of the President's Reinventing Government Initiative, all federal agencies are reexamining their missions. This includes: addressing the mission based on "customer" input; asking whether the mission could be accomplished as well or better without federal involvement; looking for ways to cut costs or improve performance through competition; and ways to put customers first, cut red tape, and empower employees. We are actively participating in this effort and will keep you fully appraised of our review.

I must say that the process of evaluating quality is not alien to the NSF. Historically, it has been at the heart of our mission and operation in choosing the best research to support.

Nevertheless, the task of developing measures to monitor our own performance in reaching our goals is a formidable challenge. We have set up several pilot projects to road-test prototype performance measures. It would be presumptuous to assume that our first attempts at these judgments will be on-the-mark in all respects. In fact, if we jump to the conclusion that they are perfect, we are likely missing the point by a large margin. But we are working hard to find ways to document our progress.

Let me conclude with the wisdom of Alfred North Whitehead who said, (quote) "The art of progress is to preserve order amid change and to preserve change amid order." (end quote)

This time of change is exhilarating for the National Science Foundation. It is significant for us, and for all the nation's institutions. We believe we have a clear-cut vision of where we need to go, an orderly path to pursue. We are confident in the goals we have set and are willing for them to take us into uncharted territory and new opportunity. We are taking Alfred North Whitehead's challenge to heart.

Thank you for this opportunity to appear before this Subcommittee. I would be pleased to answer any questions you may have.

SUMMARY OF THE FY 1996 NSF BUDGET
BY APPROPRIATION ACCOUNT

Research and Related Activities

The FY 1996 Budget Request for the Research and Related Activities (R&RA) Appropriation is $2,454.00 million, an increase of $174.00 million, or 7.6 percent, over the FY 1995 Current Plan of $2,280.00 million. The R&RA Appropriation supports activities that enable the United States to uphold world leadership in all aspects of science and engineering, and to promote the discovery, integration, dissemination and employment of new knowledge in service to society. Research activities contribute to the achievement of these goals through expansion of the knowledge base; integration of research and education; stimulation of knowledge transfer among academia and the public and private sectors; and bringing the perspectives of many disciplines to bear on complex problems important to the nation.

Merit review is the principal tool in selecting among proposals for funding. Review emphasizes the capabilities of the investigators; the innovation, importance and relevance of the ideas and approaches; and the potential for enhancing the human and physical infrastructure of science and engineering.

A summary of the Activities within R&RA follows:

The Biological Sciences (BIO) Activity fosters understanding of the underlying principles and mechanisms governing life. Research ranges from the study of the structure and dynamics of biological molecules, such as proteins and nucleic acids, through cells, organs and organisms, to studies of populations and ecosystems. It encompasses processes that are internal to the organism as well as those that are external, and includes temporal frameworks ranging from measurements in real time through individual life spans, to the full scope of evolutionary time. The 7.6 percent increase, to a total of $323.96 million in FY 1996, will primarily support research in biotechnology, biodiversity, and terrestrial ecology related to global change.

Research in the Computer and Information Science and Engineering (CISE) Activity includes system software design, theory of computing, engineering design, prototyping, testing, and deployment of cutting-edge computing and communications systems to address complex research problems. The 6.7 percent increase, to a total of $275.57 million in FY 1996, is principally directed toward research in ubiquitous computing, human-machine interaction and information access, parallel and distributed computing, and toward multidisciplinary challenges -- laying the groundwork for future information technology that can help solve complex computational and communications intensive problems of scientific and societal importance. Additional experimental high-speed networking activities will be supported. The Supercomputer Centers will initiate new cooperative activities with other high performance computation facilities nationwide, and their computational infrastructure will be enhanced to carry out leading edge research.

The Engineering (ENG) Activity seeks to enhance long-term economic strength, security, and quality of life for the nation by fostering innovation, creativity, and excellence in engineering education and research. ENG seeks to promote the natural synergy between engineering education, fundamental research, and the application of technical knowledge. The ENG Activity's 7.7 percent increase, to a total of $344.16 million for FY 1996, will primarily go to support research in areas such as intelligent sensing and control systems and environmentally conscious manufacturing. Funds are included to meet the mandated level for the Foundation-wide Small

Business Innovation Research (SBIR) program and the authorized level for the Small Business Technology Transfer (STTR) program.

The Geosciences (GEO) Activity supports research in the atmospheric, earth, and ocean sciences. Basic research in the geosciences advances the scientific knowledge of the Earth's environment, including resources such as water, energy, minerals, biological diversity, and coral reefs. GEO supported research also advances the ability to predict natural phenomena of economic and human significance, such as climate changes, weather, earthquakes, fish-stock fluctuations, and disruptive events in the solar-terrestrial environment. The 7.6 percent increase, to $451.48 million in FY 1996, will support fundamental research and national user facilities across the geosciences, including new and enhanced efforts in international programs, forecasting and climate modeling, and studies of continent-ocean margins.

The Mathematical and Physical Sciences (MPS) Activity supports research in mathematics, astronomy, physics, chemistry, and materials science. Major equipment and instrumentation such as particle accelerators and telescopes are provided to support the research needs of individual investigators. The 8.3 percent increase, to $698.28 million in FY 1996, will be directed to areas including multidisciplinary research in optical science and engineering, environmental science and technology, biotechnology, nanosciences, and will enhance support for facilities and instrumentation.

The Social, Behavioral and Economic Sciences (SBE) Activity stimulates scientific progress in these fields. Research focuses on how various social and economic systems are organized and operate, and how cognitive and cultural factors influence human behavior. Activities include the Human Capital Initiative and a consortium for research on violence to be initiated in FY 1995. The Activity also includes programs that promote international scientific cooperation and provide authoritative data on science and engineering and the characteristics of the nation's research and education enterprise. The 8.0 percent increase, to $122.87 million in FY 1996, will support research on human genetic diversity, learning and intelligent systems, and research on democratic processes.

Polar Programs, which includes the U.S. Polar Research Programs and U.S. Antarctic Logistical Support Activities, supports multi-disciplinary research in Arctic and Antarctic regions. Polar regions play a critical role in world weather and climate and provide unique research opportunities in environmental sciences, ranging from the ocean bottom, through the ice layer, and into space. The 6.1 percent increase in Polar Programs, to $234.88 million, will be directed entirely to U.S. Polar Research Programs. Priority is given to increases for arctic research, including Arctic logistics. Increases are also provided for studies of the oceans surrounding Antarctica, research on Antarctic ice sheets, and for science facilities and operations that make Antarctic research possible.

The Critical Technologies Institute, with a request of $2.8 million, is a Federally-Funded Research and Development Center that provides analytical support to the Office of Science and Technology Policy by identifying near-term and long-term objectives for research and development; analyzing the production capability and economic viability of technologies; and providing options for achieving R&D objectives.

Education and Human Resources

The FY 1996 Budget Request for Education and Human Resources (EHR) is $599.00 million, a decrease of $6.97 million, or 1.2 percent, from the FY 1995 Current Plan of $605.97 million. EHR supports a cohesive and comprehensive set of activities, augmented by informal science experiences, which encompass every level of education and every region of the country. EHR is a major participant in interagency efforts for science, mathematics, engineering and technology

education (SMETE) initiative, totaling $530.88 million in FY 1996. This initiative addresses many of the challenges posed by *Goals 2000: Educate America Act.*

- Support at the K-12 level totals $354.78 million, a decrease of $810,000 from the FY 1995 Current Plan. This support is focused primarily in the Systemic Reform activities ($95.35 million) in states, urban, and rural areas, and Elementary, Secondary and Informal Science activities that enable all students to achieve in science, mathematics, engineering and technology education.

- Support at the Undergraduate level is $102.50 million, a decrease of $640,000 from the FY 1995 Current Plan. This support is focused primarily on improving undergraduate preparation of K-12 teachers and addressing advanced technician training. Efforts of reforming curriculum and laboratory instruction, and upgrading equipment continue to be major emphases.

- Support at the Graduate level is $67.50 million, unchanged from the FY 1995 level. This support maintains the modest increases in both the stipend and the cost of education allowance provided in FY 1995 for the Graduate Fellowship program. The number of fellows will remain at approximately 2,400. The Graduate Research Traineeship program will be sustained at the FY 1995 level to maintain support for ongoing projects. No new traineeship positions are planned.

- Advanced Technological Education (ATE) established in FY 1994, is $23.35 million, unchanged from the FY 1995 level. Support will continue to focus on improving curriculum development and program improvement at the secondary and undergraduate levels to help transition students to the increasingly technology-based workforce.

Academic Research Infrastructure

The FY 1996 Budget Request for the Academic Research Infrastructure (ARI) Activity is $100 million, a decrease of $18.13 million, or 15.3 percent, from the FY 1995 Current Plan of 118.13 million.

The FY 1995 Appropriation originally included $118.13 million for NSF's Academic Research Infrastructure Activity, and an additional $131.87 million for an interagency infrastructure program, for a total appropriation of $250 million. The availability of funds for an interagency program is contingent on the development of an interagency program for FY 1996. The Administration has elected not to initiate such a program and has proposed recission of the $131.87 million, resulting in an FY 1995 Current Plan of $118.13 million.

In FY 1996, NSF is requesting $100 million for Academic Research Infrastructure, which will be equally divided between facilities and instrumentation. This represents an increase of 81.8 percent over the FY 1995 Request of $55 million. NSF believes that $100 million will provide for continued progress on renewal of these important research resources while maintaining an appropriate balance between support for research activities and infrastructure.

Major Research Equipment

The FY 1996 Request for the Major Research Equipment (MRE) appropriation is $70 million. MRE was established in FY 1995 to support construction of major research facilities that provide unique capabilities at the cutting edge of science and engineering. The FY 1996 request of $70 million represents a $56 million decrease, or -44.4 percent, below the FY 1995 level for these items.

Projects supported by this Account will push the boundaries of technology and will offer significant expansion of opportunities, frequently in totally new directions, for the science and engineering community. Two projects currently comprise the Major Research Equipment Account: the Laser Interferometer Gravitational Wave Observatory (LIGO) and the Gemini telescopes, twin eight-meter telescopes in the northern and southern hemispheres, being built through an international partnership. Per Congressional action, $35 million made available for LIGO in FY 1994 within the Research and Related Activities account was rescinded. This $35 million was restored for LIGO in the FY 1995 MRE account, with an additional $50 million requested. This brings the FY 1995 total funding for LIGO to $85 million. Also, in addition to the FY 1995 request of $20 million for the Gemini telescopes, Congress appropriated another $21 million, for a total of $41 million in FY 1995. Funding for construction of the Gemini telescopes was completed in FY 1995. No additional funds will be requested for construction of the Gemini telescopes in FY 1996.

The $70 million request in FY 1996 will permit the LIGO project to progress toward completion of construction in FY 1998 and a transition to operations during FY 1999.

Salaries and Expenses

The FY 1996 Request for Salaries and Expenses (S&E) is $127.31 million, an increase of $3.34 million, or 2.7 percent, over the FY 1995 Current Plan level of $123.97 million. The Request level supports an authorized ceiling of 1,226 full-time equivalents (FTEs), provides for current administrative levels, and continues the investment in information technology for administrative processes.

Salaries and Expenses provides funds for staff salaries and benefits, and general operating expenses necessary to manage and administer the NSF. Funds are requested separately for FTEs and direct expenses of the Office of Inspector General and for NSF Headquarters Relocation, the appropriation account which includes funds to reimburse the General Services Administration (GSA) for expenses incurred to relocate the Foundation to its new Headquarters location in Arlington, Virginia.

NSF Headquarters Relocation

The FY 1996 Request for NSF Headquarters Relocation is $5.20 million, equal to the FY 1995 level. This appropriation account provides annual reimbursement to the General Services Administration (GSA) through FY 1999 for expenses incurred by GSA pursuant to the relocation of the National Science Headquarters to Arlington, Virginia, which was completed in January 1994.

Office of Inspector General

The Office of Inspector General (OIG) was established to promote economy, efficiency, and effectiveness in administering the Foundation's programs; to detect and prevent fraud, waste, or abuse within NSF or by individuals that request or receive NSF funding; and to identify and resolve cases of misconduct in science. The FY 1996 Request for the OIG is $4.49 million, an increase of $0.11 million over the FY 1995 Current Plan.

Senator BURNS. We have been joined by two of my colleagues, and we welcome them to this hearing this morning.

Gentlemen, I never read an opening statement. I have one that I am going to put in the record, and probably follow-up on with some questions, but we have a vote at 10:20, for which we are a little bit late already.

[The prepared statement of Senator Burns follows:]

STATEMENT OF SENATOR BURNS

Hearing on the FY96 Budget of the National Science Foundation and the Office of Science and Technology Policy, March 30, 1995.

This hearing will now come to order. Let me first welcome our witnesses here today to this hearing on the FY96 budget of the National Science Foundation (NSF) and the activities of the President's Office of Science and Technology Policy (OSTP).

Dr. Jack Gibbons, director of the Office of Science and Technology Policy (OSTP), is no stranger to this Subcommittee or to the Congress. For 14 years, Dr. Gibbons provided us with advice and analysis as director of Congress' Office of Technology Assessment. These days, it is the Executive Branch that is the beneficiary of his wise counsel and it is lucky to have him.

I also want to welcome Dr. Lane, the director of the National Science Foundation (NSF). I believe that NSF has done more than any other R&D agency to prepare our colleges and their students for the technological revolution through its science and education programs. I also want to acknowledge the witnesses from a second panel on EPSCOR, including Dr. Bob Swenson of Montana State University, Dr. Royce Engstrom with the South Dakota EPSCoR program, Dr. Joseph Danek, Director of the EPSCoR Foundation, and Dr. John Saunby, Director of the Union Caarbide Technology Center in South Carolina.

These are exciting, but difficult, times for our federal science and technology enterprise. On the one hand, we are in the midst of a technological explosion. Advanced computer networks now allow scientists from different continents to conduct joint research and share information in real time. Virtual reality technology permits engineers to walk through buildings and products that only exist in the computer. Microelectronics allow us to build planetary spacecraft no bigger than your office desk. This is truly a revolution.

On the other hand, Congress is struggling to reduce the federal deficit. As a result, many federal R&D agencies can anticipate flat or declining budget profiles. At the same time, these agencies still face the pressure to continue to produce scientific miracles and marvels. Clearly, an overall federal strategy must be developed to adjust to this new environment. In that connection, I would simply make a couple of points——

First, we must set priorities. Some science and technology programs are more important than others. With flat outyear budgets, we cannot fund everything and hard decisions have to made about what to support and what to let go. The new emphasis on "strategic research" and "critical technologies" perhaps reflects that reality. That having been said, we also must not abandon our traditional support for the basic research supported by the NSF and other programs. Many of our Nation's most important scientific breakthroughs have come from small curiosity-driven efforts, not billion-dollar, multiyear initiatives.

Second, we must develop better ways of evaluating our science programs so that if they are not working, we can divert our resources to other areas. Too often, we continue to support science programs without any regard to their effectiveness. Ineffective programs become self-perpetuating entitlements and develop a life of their own. As Congress advised the National Science Foundation several years ago, we need to develop performance milestones for science projects and assess whether these milestones are being met.

Third, where appropriate, we should seek industry partners in the development and funding of science programs. Involving industry, both early and often, insures that its needs are taken into account in structuring the projects and it reduces the projects' cost to the taxpayer. While the U.S. remains the unchallenged world leader in the pursuit of basic science, again and again, Japan and other countries have done a better job of converting science to commercial goods and services that the taxpayer can use. Industry involvement can turn that around.

A final point in this regard involves the importance of international cooperation. We have already recognized that programs as such Space Station and the Global Change Research Initiative are far too expensive and complex for the U.S. to tackle

alone. Improved communications networks and the emergence of global markets have created a much friendlier environment for these kinds of cooperative efforts. We need to take advantage of that.

In addition to reviewing the overall federal science policy, this hearing will focus on the FY96 budget request for NSF. For FY96, NSF has requested $3.36 billion, an increase of 3 percent over the FY95 funding level. This funding level should allow the agency to continue its excellent science and education programs.

I note, however, NSF's FY96 budget request for its facilities program did not match the FY95 appropriation of $250 million. Because of that, by the terms of the FY95 appropriations legislation, NSF automatically lost the $132 million in FY95 that was specifically designated for a new multiagency facilities program. This is obviously disappointing. We have a $10 billion backlog of academic research infrastructure needs. Good research requires good facilities and good lab equipment. Unless we are going to start to address this problem instead of putting it off, our Nation's basic research is in jeopardy.

This is not just an academic problem. For instance, Montana Tech recently submitted a grant proposal to renovate its 75-year-old Chemistry Building. The proposal was favorably received by NSF and recommended to be funded—if funds were available. Those funds, of course, were not available because the facilities program was not adequately supported in the Administration's FY96 budget request. Hopefully, we will address the facilities issue during the hearing.

I am concerned that the budget request for NSF's EPSCOR program, now at $36 million, decreased funding by 3% for FY96 while the budget request for NSF called for a 3% increase. I will be interested to hear if NSF is decreasing the emphasis of the EPSCOR program. For Montana and other rural states, EPSCOR programs at NSF and other agencies allow our research institutions to play a role in the $70 billion federal R&D enterprise. For years, our quality research institutions were shut out of the competition for federal research grants. The peer review process, while fair on its face, tended to favor the more established colleges, who were more familiar with the selection process and culture. As a result, the rich got richer.

EPSCOR insures that our colleges have an opportunity to compete for research grants and make valuable scientific contributions to our country. Our second panel of witnesses represents EPSCOR success stories and I am very eager to hear their testimony about their experiences in the program.

Finally, we hope to look at NSF's science education programs. Strengthening the math and science literacy of our young people is the only way to insure their involvement in our increasingly technological world. We have learned that students' interest in math and science is usually sparked in their early years, often as early as elementary school. For that reason, I am especially interested at activities aimed at K through 12 education. I also think it is crucial that we use the new communications technologies to make our educational system more effective. At Montana State, for instance, NSF currently supports a distance learning/teacher enhancement project to improve the skills of teachers in the more remote areas of the northwest. These are the kinds of activities that we need to stress if our Nation is to remain competitive.

Again, let me welcome our witnesses and I look forward to todays hearing.

Senator BURNS. I would invite my colleague and ranking member on this committee, Senator Rockefeller, if you have an opening statement that you would like to make at this time, with some comments, why, I plan to, whenever we have the vote, just to recess the hearing until we go vote and come back, and then we will finish it up.

So, Senator Rockefeller, thank you.

STATEMENT OF SENATOR ROCKEFELLER

Senator ROCKEFELLER. Mr. Chairman, I do have some comments. I am going to work them, however, into some of the questions that I ask. So I will just put my statement in the record.

Senator BURNS. Thank you.

[The prepared statement of Senator Rockefeller follows:]

PREPARED STATEMENT OF SENATOR ROCKEFELLER

Mr. Chairman, with this hearing, you are continuing to show your interest in programs and issues extremely important to the country's economic strength. This is

another chance to review federal programs that support science and research and their value in making progress in human knowledge, in technology, and in the lives of the people we represent.

I welcome our distinguished witnesses. Dr. Gibbons and Dr. Lane are the top science officials of this Administration. Both are highly respected leaders and intellects. We also have an excellent panel of witnesses to discuss the Experimental Program to Stimulate Competitive Research—EPSCOR. As Senator Burns knows, EPSCoR is an important program in his state and mine. In fact, I have a long history in promoting the premise behind EPSCoR—that the states without an MIT or Stanford deserve some targeted help to make sure good science, research, and technology are "growing" everywhere in America. These are the keys to making human and economic progress in the modern world, and every state should have them to open the door to the prosperity that the whole country should count on.

I want to give a special welcome to Dr. John Saunby, here to share West Virginia's experience with the EPSCoR program. He is an active member of West Virginia's EPSCoR Committee, which is one of the ways that this program promotes collaboration among the business, academic, and public sectors. Dr. Saunby, now retired, had a very impressive career as Director of R&D at a Union Carbide center in Charleston, West Virginia, where flagship research is conducted in areas like chemicals and plastics.

This hearing comes at a privotal time. With a federal deficit that must be eliminated, Congress is taking a hard look at how public funds are being spent. But just as fiscal pressure is increasing, the economic challenges from our competitors are getting stiffer. That means that science and technology policy has to adjust to the needs of this post-Cold War era when federal money is getting much tighter.

Somehow, we have to figure out how to avoid abandoning the programs harvesting the intellectual, human, and economic riches that define the United States of America. I hope the federal deficit doesn't cause us to surrender economically to other countries or abandon the investments that define our future. We also have to seize the growing opportunities—because geography and terrain aren't the barriers they once were—to involve all of our states, along with small businesses, not just large corporations, in these efforts to make advances in science and technology.

I am interested in a few issues in particular.

First, what policy for science and basic research is most appropriate for today? For example, I am skeptical of the notion that basic research and tax cuts alone are sufficient to ensure U.S. technological leadership. Nobel Prizes are invaluable, but not nearly enough by themselves. There is a large gap between basic research, on the one hand, and product development, on the other. Increasingly, American companies are hard-pressed to fund the mid-level research on new breakthrough ideas.

We need research mechanisms to help American companies take advantage of our great wealth of basic research. That is why both the Administration and many in Congress also support private-public research partnerships to overcome the technical problems associated with new technologies.

Second, will the government's basic research budget be adequate to meet needs? We all know that the budget must be cut, but it is possible that basic research cuts this year in the Department of Defense and other relevant agencies will leave big holes in the needed support for university science. For example, DOD historically has supported much university research in the physical sciences and computing. Can or should NSF make up any difference? What are the consequences of cuts being made as we speak or the ones being contemplated down the hall?

Third, are additional steps needed to build and maintain the capabilities of research universities throughout the United States? With university research increasingly important to economic development, we need to ensure that all states have an opportunity to build their science and technology strength. Again, EPSCOR is important, and I am pleased we will look into its mission and work today.

Mr. Chairman, I look forward to hearing from our distinguished witnesses.

Senator BURNS. The Chairman of the full committee, Senator Pressler, from South Dakota.

STATEMENT OF SENATOR PRESSLER

The CHAIRMAN. Mr. Chairman, let me congratulate you on this hearing. I shall place my statement in the record.

I am proud that later this morning Dr. Royce Engstrom, project director for South Dakota's EPSCoR program will be here testifying.

I hope to be able to come back. I have some floor amendments I am working on. But I thank the witnesses. And I have some questions for them, but I will ask them at the proper time.

[The prepared statement of Senator Pressler follows:]

PREPARED STATEMENT OF SENATOR PRESSLER

Mr. Chairman, I want to thank you for holding this hearing on the White House Office of Science and Technology Policy and the FY96 budget of the National Science Foundation. This hearing could not be more timely. Just last week, OSTP reported that U.S. leadership in most of 27 critical technologies is slipping. While the U.S. is still the leader in science and technology, Europe and Japan are rapidly closing ground.

This is very disturbing. Increasingly, our industrial competitiveness is linked to our ability to stay on the cutting edge of science and technology. Many of the new markets with the highest growth potential are in high-tech areas such as communications, computers, and biotechnology. Equally significant, our military success in Desert Storm was directly attributable to U.S. technological superiority over our adversaries. Unless our Nation develops a comprehensive policy aimed at maintaining a strong science and technology base, America's economic and national security will be at risk.

The Subcommittee is very fortunate today to have two Administration officials who play pivotal roles in setting and implementing our national science policy—Dr. Jack Gibbons, Director of OSTP, and Dr. Neal Lane, Director of the National Science Foundation. I look forward to hearing their views on where we are headed in science. I believe one positive development from last November's elections is that it has provided us with a unique opportunity to consider new approaches to science and technology policy.

One concept that is receiving more attention this year is "privatization." We in Congress are taking a hard look at privatizing those government activities—in science and elsewhere—that can be performed more cost-effectively by the private sector. For some programs, privatizing may have the potential of both reducing costs and improving service to the taxpayer. Once considered extreme, privatization proposals now are gaining wider acceptance. For example, the recent report by Chris Kraft on the Space Shuttle program recommends our Nation's Shuttle program move toward a privatization model.

Other proposals have focused on restructuring our system of 700 federal laboratories. Many of these facilities continue to pursue outmoded Cold-War missions and conduct research which, unlike university science, is not peer-evaluated. Much of the new thinking on this issue includes proposals that the lab system be consolidated and run by a corporate-type board and that the labs' research projects be forced to compete—on merit-with science proposals from colleges and other institutions. If we are going to get the most out of the federal R&D budget, these kinds of proposals must be given serious consideration.

I also am concerned our $70 billion federal science and technology enterprise be made more relevant to the taxpayers that pay for it. With regard to many science programs, my home state of South Dakota and other rural states have had little, if any, involvement—either as participants or beneficiaries. We, too, must be part of the technological revolution. In that regard, the National Science Foundation has done a tremendous job of including rural states in that revolution. I know NSF's science and education programs have a significant impact on several universities in South Dakota. NSF's EPSCoR program has been particularly helpfiil in that regard. That program is specifically aimed at strengthening the research capabilities of colleges in states which historically have been unable to compete effectively for federal research opportunities.

Currently, EPSCoR is finding several important activities at three schools in South Dakota: the University of South Dakota, the South Dakota School of Mines and Technology, and South Dakota State University. NSF activities have been crafted to reflect the special expertise of those universities as well as the particular needs of our region. For instance, I understand important work is being done in life sciences, which could benefit our farming community greatly. NSF also is supporting research to improve remote sensing to take better advantage of Sioux Falls' EROS Data Center, which archives the Nation's Landsat imagery. Beyond the research projects, the program also supports educational activities reaching students in South Dakota at all levels. I hope to hear more about these and other EPSCoR activities from Professor Royce Engstrom of the University of South Dakota, who

coordinates all of the EPSCoR programs in South Dakota. I extend a special welcome to Dr. Engstrom.

Again, I thank Senator Burns for holding this hearing on federal science policy and the National Science Foundation and look forward to the testimony of our distinguished panel of witnesses.

Senator BURNS. We will just get into a little dialog this morning, Dr. Gibbons and Dr. Lane.

If you will, just for the record and this committee, go over your 1996 budget request for your office, the activities that you are going to support by that budget, if you could just give us an overall picture, what you think the important things really are, how the main activities are going to be allocated among your four associate directors.

So if you can, just give us an overview on your budget requests and where your thrust is going to be in 1996.

Dr. GIBBONS. So you want to proceed with it now, before the vote.

Senator BURNS. Yes. We will until the buzzer goes off.

Dr. GIBBONS. Until the buzzer goes. All right, sir.

The Office of Science and Technology Policy, which you need to know is now the—that one budget covers the OSTP and the original work that was part of the National Space Council and the National Critical Materials Council, and now also the work of the National Science and Technology Council, and the President's Science Advisory Committee, is requesting a budget of a little under $5 million, the same dollars as we had in fiscal year 1995.

This supports our entire staff, which includes four associate directors and myself. The resources are basically partitioned out, once we pay our rent, to the four divisions under our four associate directors.

And we trade work back and forth within the office. But those four divisions include science, technology, environment, and international security, and international—international science and technology and international security.

The work of the office is to be the focal point for the Executive Branch, not only in giving advice to the President and the Vice President, and other members of the executive offices, but to be the place where interagency activities occur, where we develop science policy as a group, where we catalyze activities between the various agencies that carry out science and technology policy.

One example of our work is a forum that is ongoing this morning. I just left Senator Lugar, Senator Nunn, and Secretary Perry, who are addressing a forum that we have assembled that has to do with the role of science and technology, both in national security and in global stability.

That is one of our jobs, is to try to work at the over-arching goals of government, and then map the resources of science and technology into those goals.

Another activity is to help create a better coordinated and leaner budget. I brought with me this morning one example of a strategic planning document, with respect to, in this case, environment and national resources across the whole Federal Government.

And this study, which was carried out in the last twelve months by a group of two dozen agencies, all of which have a piece in environment and natural resources, represents now an integrated strat-

egy in which all the agencies agree on how they can, together, carry out this over-arching work.

That affects then the budget preparation and the agency budget submissions.

So our job is, I would say, if I were a chemist, I would call it, it is a catalytic job. Our job is to try to help merge these agencies together in a way that they can collectively have a much more coherent and tightly focused program.

It is also to help the President in achieving his objectives related to science and technology, which include putting some pieces together that was difficult to do before, until he created the Science and Technology Council.

For example, with the Council and with the President's engagement, we have been able to merge both the civil and the military activities now into other satellites.

So instead of having separate satellite systems for weather, we now are moving to an integrated combined Federal and civil weather satellite capability.

We are doing this in a number of other areas, where we are trying to make real sense out of this notion of dual use and higher efficiency of government.

Senator BURNS. You mentioned in your testimony that you are ahead of our counterparts in Japan and the European community right now, but that is starting to shrink.

Give this committee some idea of where the Europeans are, where they are excelling right now, and where we should be.

We are losing a little bit of ground, and the same with our friends in Japan.

Dr. GIBBONS. Well, Mr. Chairman, it will take a little bit more time than you probably have——

Senator BURNS. Well, just give us the areas of your concern that probably should be our concern.

Dr. GIBBONS. One of the areas of concern that we have is that these—where these shortcomings occur happen not only for our civilian sector, but also for our military, areas such as very advanced materials capabilities, flat panel display, ways of taking information and putting it on flat screens rather than on vacuum tubes and the like. That is just but one of many.

Areas of capability, for example, to do the testing of aircraft at very high velocities. We have to go to France now, for instance, to do internal testing in some of these advanced aircraft. So that is a second area.

Areas of very advanced design capabilities for complex engineered systems is an area where we lead, but other countries are catching up with us quickly, so we have to look not only at how we stand, namely on top of the pack.

But at the rate at which these other countries are coming after us and gaining on us in this regard, we used to enjoy enormous leads in these areas, and now it has shrunk down to where it is getting closer to zero.

Senator BURNS. Is this because there is more dissemination of basic research, that they start at a higher platform now than they once did. They start with the knowledge that we know now. That

would close the gap. That would speak to that, it would seem to me, anyway.

Dr. GIBBONS. It does. But technology depends on people, and you cannot get technology by reading it in a book. If you look at the investments as a fraction of their economies, compared to our investments in this area, as a fraction of our total economy, they are plowing more of their economy back into these sorts of things, especially in the non-military, in the various esoteric non-military areas.

If you look at total dollars, we are still ahead. If you look at fraction of our total economy, we are near the top.

We are within the first four or five.

If you take away the military investments and look at the civil sector investments in science and technology, we drop down below basically every other industrial country, and we are around twentieth.

Senator BURNS. Senator Kerry, we have all had statements, but none of us gave statements, and we have already had the opening statements from Dr. Gibbons and Dr. Lane. Is there an opening statement you want to make?

Senator KERRY. No.

STATEMENT OF SENATOR HOLLINGS

PREPARED STATEMENT OF SENATOR HOLLINGS

I am pleased that the Science Subcommittee is holding this morning's hearing on Federal science programs, including the programs at the National Science Foundation. And I am particularly pleased that my old friend Jack Gibbons is testifying, along with Dr. Neal Lane and a distinguished group on experts.

Today we are involved in a major debate over the role and size of government. And we are hearing a great deal of rhetoric on these issues. But all of the rhetoric does not change one fundamental point—this country will not prosper in the years ahead unless we have a competitive trade and industrial policy. That does not mean heavy-handed government control. It means economic and business policy similar to what many governors, both Democrats and Republicans, have done to promote economic development in their states. It means good, cost-effective, industry-oriented efforts to help our companies and workers succeed.

In the science area, we must continue two efforts. We must ensure that our great scientific enterprise stays healthy and continues to pursue basic research in areas of national importance. That means supporting basic research in fields as diverse as health, manufacturing, and advanced computing. With budget cuts inevitably coming, we must carefully review our priorities. Second, we also need programs that will help American companies take advantage of this basic research. Basic science is vital, but if Nobel Prizes alone guaranteed economic success then our streets would be paved with gold. They are not, and our companies in fact face tight corporate research budgets and unprecedented technological competition. As a result, our country needs technology partnership programs like the Advanced Technology Program. And we need extension efforts such as the Commerce Department's manufacturing centers.

The irony about this year's debate is that we know what programs work in the real world, and which kinds of programs are making a difference to real companies. I hope we can get past all of the government-bashing and focus pragmatically on what we can do—both in the science field and other policy areas—to help improve our standard of living and quality of life.

Senator BURNS. There is a vote on now, and I plan just to recess, and we all go vote, and come back, and we will all pick it up at the same time. Is that suitable to everybody?

We will stand in recess for about 10 minutes. We will go vote, and we will be right back. [Recess.]

Senator BURNS. I will call the committee back to order, please.

I have one more question while Senator Rockefeller has a little business to take care of.

Dr. Gibbons, I support the ATP programs, because I believe it provides critical seed money to companies that need an initial helping hand to get started, and to attract private capital.

This gets to be a problem every now and then.

Nevertheless, it was surprising that at a time when NASA and other R&D agencies are cutting back, the President requested $491 million for ATP in fiscal year 1996. That is a 14 percent increase.

We have come under some criticism with the ATP, as you well know, and I would ask can we justify this kind of an increase in light of everything else being cut back, and how do we answer our criticisms of the tremendous growth and funding for that particular program.

Dr. GIBBONS. Senator, I think probably the first answer I would like to say is that while ATP has been growing rapidly, it is growing from almost a zero base, and by the time we get even well beyond the presently proposed size of ATP, the entire program is less than one of our Federal laboratory's budgets. So in proportions of the total research activities, we are talking down in the 1 percent range.

The second thing is that when you go to ATP, you have industry directly involved with their money on the table, too.

So you are at least doubling your investment, because it is typically a 50–50 split of investment, so that doubles the effort by attracting in that kind of private capital. So it has a very high leverage.

And third, it addresses this very critical gap that I know we are all concerned about, mainly that we generate new knowledge very effectively, but we have been having a real problem in times past in transforming that knowledge into the marketplace for goods and services.

So that is exactly what this program gets at. It selects out the kinds of ventures that, if they are successful, will have a major impact on a wide variety of American industry, in terms of staying ahead of the curve.

And I think it is for those reasons that we would like to see this program get up to the level that we are talking about, but even when it gets to it, it is still a very small fraction of our total effort.

Senator BURNS. Dr. Lane, can you give us the chief goals and priorities for NSF? You are taking a look at fiscal year 1996, and I know that you have done an awful lot of soul searching over there. You might give us an idea of what your priorities are for 1996.

Dr. LANE. Mr. Chairman, as I indicated earlier, our request is a 3-percent increase, which is a very good budget in tough times. Our priorities are research and education.

That is pretty much all we do. We carry out those activities using the merit review process. We are focusing, in particular, in the 1996 budget on research projects, individual investigators and small groups carrying out research in the nation's universities and college laboratories.

We are focusing there, because this is a very highly selective process. We turned away over $1 billion worth of proposals that we could fund, based on this highly competitive process.

We have success rates of proposals submitted that go as low as 15 percent in some of our areas. The average is higher than that, but in many fields, the rate is quite low.

We want to make sure that we are making the best possible investment of the Federal moneys in the programs that we know from analysis, pay substantial dividends in the future.

Our Academic Research Infrastructure program, which funds the modernization of laboratories in universities, colleges, and the purchase of medium-scale shared-use equipment, equipment that is too large for one research grant, but not major facilities, that program is funded at slightly higher than $100 million in 1995.

But our request in 1996 of $100 million is the largest request we have ever made in that area. So certainly we feel that this is an important need for the academic research community.

And we support strongly a multi-agency effort to make some progress in this area. And the President's National Science and Technology Council, in particular, an activity under the Fundamental Science Committee, is studying that issue right now.

Our Education and Human Resources Directorate contains most of the education activities in the K–12 area, essentially all, and most of the undergraduate education, but, in general, education permeates everything NSF does. So when we have a researcher working in a laboratory with students, education is going on.

The reason the EHR Directorate does not increase, in fact, decreases slightly this year, is because our priority is on research.

The education efforts are very important ones. As I mentioned in my testimony, that budget has grown very substantially over the last decade. We are in a time of comprehensive evaluation of all of those programs.

And we want to make sure that we put our money on the things that work best, and we are in the process of determining that.

We feel that our budget request does show priority setting. It makes tough choices, and we certainly hope to get support for the request submitted.

Senator BURNS. Senator Rockefeller.

Senator ROCKEFELLER. Thank you, Mr. Chairman.

I want to talk a little bit about the kinds of basic research, applied research, et cetera, that I think—this is addressed to either of you or both of you—that is most appropriate for today, because it is interesting that at the time we are having our fiscal crises and dealing with our fiscal crises at the exact time that we are most worried about R&D being done in our country versus other countries, and the competitive edge, and all that.

So these two things come together, and they obviously do cause a conflict.

Now, I think the President wisely avoided that conflict with respect to you two gentlemen, and that is very important. But what worries me, to some considerable extent, in fact, is there a divergence that I think is growing sharper between Republicans and Democrats in the Congress as to the role of the government in all of this.

I think that the Democrats generally support devoting money, not much, but money in partnerships, government-private industry

partnerships, and basic research, the fundamental scientific work in areas that mean something to the nation's future.

We tend to support strategic research, whether it is the 25 critical technologies that Commerce and DoD have agreed on, and we tend to say if we do not have those by the 21st Century, which is four-and-half-plus years away, we are not going to be able to compete.

So whether it is venture capital, or whether it is joint venturing, or whatever, we tend to want to do that kind of thing.

The Republicans are more skeptical about that, believing that, as Chairman Walker does on the House side, that if the science is good enough industry, and if the economy is growing, industry is going to pick it up and do it, and the government should not be involved in that.

Now, that is interesting, because it was President Reagan's OSTP that developed a high-performance computing initiative, and it was George Bush's administration that worked on global change and manufacturing programs.

But nonetheless, these conflicts have arisen, and I think they are important to deal with. I have a couple of questions. The first is, Chairman Walker, although he does support basic research, appears to support what he calls a linear or a pipeline theory of technological innovation.

This model says that basic research leads directly to applied research and product development, you know, just boom, boom, boom. It is just, if one happens, then the other two are going to happen.

There are a lot of analysts, however, that say that innovation is a whole lot more complicated than that, a whole lot more interactive than that, and that a company, if it sees technical risks, and does not others willing to be helpful, they get worried and they do not go ahead.

I would like to have each of you discuss that in a non-partisan fashion, because it worries me greatly. I have seen it operating this year, more than last year. It had its genesis a number of years ago in the so-called $10 million commercialization amendment, which we all know about.

But I would appreciate it if you would talk about that, because I think it is probably at the heart of the greatest conflict here on the Commerce Committee.

Dr. GIBBONS. Senator Rockefeller, it is an issue that I think is globally being asked now in addition to the dialog going on within Congress between both sides of the aisle and with the administration.

I spent some time last night speaking with my counterpart from Hungary. They are having the same situation there. So it is a global issue of the role of governments in a modern industrial society.

I think that the position that the President has taken, and I strongly feel is appropriate, is that there is a role for the people, through government, an important role to play in providing for our futures, and that investment in science and technology is an agent to enable that kind of a future that we would desire to emerge.

The question is, how do you sort it out between a public dominated activity, such as fundamental research, and a private dominated activity, such as turning knowledge into products.

Now, there have been, in times past, what has been called the linear model of research and development of applied and basic, in which somehow you start with a discovery at the bench, and that proceeds to applied research, and that proceeds to pre-market technology, and that proceeds to products, and goods, and services.

The work that we did a year ago, and resulted in a publication called "Science in the National Interest," points out that there is now essentially a full consensus that that model is really not correct.

But what happens with new ideas is that there is this interaction between the fundamental work and the development of technologies, and, in turn, the marketplace.

It is in that rich set of feedback loops that occur in our society that we have enjoyed so much gain here in these past several decades.

That is the reason, for instance, the Bell Telephone Labs being located right up next to production and product development in AT&T was such a powerful combination. If you separate those things, then you have created a gulf that gives us real problems.

So we believe in trying to help—not only sustain the notion that fundamental research is fundamentally a governmental activity, because the gains are large, but they cannot be captured by the individual firm. They are public gains. They distribute across industry and the rest of our society.

On the other hand, when gains can be captured by the firm, then that is a very appropriate and necessary and fundamental role for industry. I do not think industry has a basic problem with these things.

Most of the industrialists I talk with sort this out pretty readily, and they do support things like, for instance, the ATP, in general, because they see that as the merging grounds where you are cost-sharing, you are doing it on the basis of an industry-led kind of activity.

But the public gain in there is so large that when you add some public funds to the private funds, with this kind of lined up mutual interest, then you get over the hurdles that otherwise you cannot get over, because industry should not be expected to make an investment where they cannot capture the return. And that is the basic problem, as you move up toward basic research.

I would be happy to go on, but I have already used up my time.

Senator ROCKEFELLER. Would you like to add something, Dr. Lane?

Dr. LANE. Senator, as you know, NSF makes most of its investment in universities and colleges, so the interaction with industry takes place there. It is cooperation between a university and a company.

Many of our programs, particularly the Engineering Research Centers, Science Technology Centers, have corporate partners.

I talk with them from time to time. We are very pleased that they are interested in basic research that NSF supports, and ask why are they interested, and get different reasons from different companies.

There are lots of different sectors. My view is that one can find examples where the linear model works just fine, and then one can find many examples where it is much more complex.

We find small companies who want to have people in the university's research laboratory for a substantial amount of time, and they help contribute to the cost of doing the research.

That is good for the university, because that brings important information to help improve the educational environment for the students. They know better what students need to learn. It helps industry, because industry has access then to the discoveries.

So we think the partnerships are very important in the programs that we support, and in our interactions with industry, we get very strong statements of support for continuing those activities.

Senator ROCKEFELLER. Mr. Chairman, could I add just one question——

Senator BURNS. Sure.

Senator ROCKEFELLER [continuing]. Is that OK? The global competitive situation, as dynamic as it is, has really caused a lot of large corporations to look at their research and development, and frankly, in many cases, to freeze their research and development, and to make it a much less significant part of what they do. Then you mentioned Bell Labs, and that is a classic example. They are just doing a fraction of what they used to do.

Now, the question, I suppose then, is: What does that mean, in your judgment, Dr. Gibbons, for the long-term Federal role in support of long-term research and development, given the context of my previous question?

Dr. GIBBONS. Senator Rockefeller, I would first like to add a point I omitted in my last answer, namely, this business of the public-private ventures. I think your properly mentioned that high-performance computing was a Reagan Administration initiative.

The advanced technology program was a Bush Administration initiative, and my predecessor, Alan Brownley, was, I think, properly proud that they were authors of that, and it had its origins under a Republican administration. So I think it has a strong bipartisan basis.

Senator ROCKEFELLER. Doctor, there are a number of us that worked very, very hard, bringing in Secretary Perry, John Deutsch, and others, opening up forums to Republicans and Democrats, both members and staff, to talk about ATP, to talk about TRP, to try to show how dual use from the Defense Department was something that they valued, it was good.

All of a sudden, these have become very controversial, in some cases, ideological, and what was accepted several years ago now is looked upon very, very carefully, almost like a chasm.

I mean, do you believe that government should interfere or do you not? It has become, in some ways, ideological.

Hence, I am disturbed, because it seems to be not so much to be practical and what ends up serving the country best, but rather what fits the philosophy best.

Dr. GIBBONS. I share your disturbance, because the basic facts have not changed. In fact, the facts that have come in over the past couple of years further underscore the value of these programs.

So I would hope that we could get back to looking harder at the facts, and making our decisions based more on the evidence, than perhaps is now in the noise level of the present debate.

But you also mentioned this question about the change of situation between what we used to obtain when industry carried out a lot of, in fact, fundamental research.

I think we can all remember that, let us take the Bell Labs again, that was an industry that was regulated, and, therefore, had certain protection of its markets and profits, and therefore, was able to roll in that kind of research.

When new regulation occurred, and there was an open free market operating, that kind of protection of research was no longer there, and the industry generally feels that that is not there, it transforms, it is still, in a sense, a publicly subsidized activity, except it moved from a subsidized industry to the Federal programs. I would like to give you one small example of what is happening these days.

Very advanced work on the nature of materials, inorganic materials, organic molecules, living cells, more and more is depending on a technique called neutron scattering.

The latest American physics Nobel Prize, by Clifford Show, was based on his work earlier on neutron scattering. We used to have the world's lead on neutron scattering capabilities, to take big machines, a large reactor or a large accelerator. That lead now is in Europe.

Americans are faced with the question, do we want to have that kind of capability? It is not a system that an individual industry could possibly justify building. It is an opportunity, though, for the public to invest in a fundamental facility that can be used for fundamental work, or also on the side for applied work.

We are now facing the question of should the U.S. regain its lead in neutron scattering for this enormously wide variety of opportunities in fundamental and applied science, or should we hand it off to Europe?

That is the kind of question that this and next year's budget is going to have to deal with, because the way the budgets are going, we are simply not going to be able to afford to build such a system, and we are going to hand off the lead to Europe.

Senator ROCKEFELLER. Thank you, Mr. Chairman.

Senator BURNS. Dr. Gibbons and Dr. Lane, it always seems to me like, to follow the thinking of Senator Rockefeller, that we have come under criticism that some people would call even the ATP or the manufacturing technology, in other words, we are starting to pick winners and losers, and that is industrial policy.

That should not be set here in the halls of Congress.

That should be in the private sector.

I know whenever we start making our grants, and we start doing business with people, we have to make that decision. It is a very fine line in developing the criteria of where we go and where we do not go, or if we help at all, from public funds.

Is there a criteria that you have developed on how do we do that, and not be accused of setting industrial policy?

Dr. GIBBONS. Yes, sir. And I think it is reflected in the ways the ATP is organized, and the TRP. The fact that they are fundamen-

tally cross-shared, that they are industry led, not government led, that they focus on technologies that do not just provide a firm with a profit and a product, but they provide a technology and a capability that has ubiquitous implications for other industries as well, in other words, advances that enable a great variety of industries to be able to hone their skills and compete better in the marketplace, and they are also done purely on merit and merit review.

There is no pork in there. They are strong and well-defined milestones, and advance about when you either go ahead or you turn it off, and then comes evaluations.

So with these various kinds of checks and balances in there, this thing could not be farther away from what people describe as the so-called industrial policy.

On the other hand, I believe it does reflect the extraordinary record that America has in these kinds of co-venturings in the past, because we have enabled very broad technology, such as aviation, agriculture, to come forward, and they are now our leading, strongest, and resilient industries we have.

Senator BURNS. Well, we are going to come to you for a little bit of help over in agriculture. I think from the hearing we had the other day, and you pretty well know where we are coming from, we keep seeing the dwindling of funds in ARS, Agriculture Research Service, and I am concerned about some of our areas, because I still think, no matter what we do in this nation, we eat first.

And if you do not feed a society, sending a rocket up in the air does not mean a damn thing if you are hungry. So I think we have to put our priorities in line.

Another area that I am going to ask another question in, and then I have no more for this panel, but I am concerned a little bit, because I am very much supportive of the EPSCoR.

EPSCoR has enabled small institutions in rural states to help us do a lot of things in R&D in our institutions.

But I know that we have a cutback of about 3 percent,

Dr. Lane, in EPSCoR, and I am wondering is that an indication of greater cuts to come, or are my feelings ill-founded?

Dr. LANE. Mr. Chairman, the EPSCoR program, as you know, is a merit-based program. It is a very strong program and, we think, quite a successful one.

We are in a 2-year period of comprehensive review of the EPSCoR program, in the same sense that it is a real challenge to reform the nation's education system, and, therefore, we must proceed cautiously and very selectively.

The EPSCoR program is trying to do something very challenging, but also, very important. It is to enable states that have not had a significant amount of R&D funding to become competitive, or rather for the researchers to become competitive in the grant process, and to help establish a science and technology base.

It is not a program expected to continue to support science and technology in a state. It is a program to lift, to give a leg up. As I said, we see many excellent examples of success in that program. We strongly support the program.

The slight reduction in the 1996 request does not mean it is not a high priority for us. It means that in that particular year, in 1996—for the reasons I said earlier, that I will not repeat, we want

to make the investment in the normal grant process, because, well, to put it in EPSCoR language, I guess, once we have gotten a faculty member competitive for the normal grant process, if there are not enough grants given at that stage, so that the person is left stranded, then the balance is wrong, it is not working.

We do not know that the balance is wrong, and this is not a signal that we would expect to, in any way, lower our priority of the EPSCoR program. Our evaluation is to give us all the information we need on that.

But we want to make sure that the normal grant program is for everybody, including these wonderful success stories, individuals who graduated from the EPSCoR program. We want to make sure those opportunities are there.

Senator BURNS. Well, thank you. That is all the questions I have. I want to just thank—do you have any more questions? OK.

Then I will just—well, I want to thank each one of you for your interest, but I also want to thank you for the cooperation that you have shown to me in working me through this, because I am not a technical person, and I am not a scientific person, I am just a person.

Your leadership on this, and helping me understand, and get over some rough things, I really want to thank you for that. I appreciate your cooperation very much in working with me. I know at times it is probably quite trying.

Dr. LANE. Mr. Chairman, could I thank you in public for the dinosaur tooth that you presented me at the EPSCoR celebration a couple of weeks ago? It is in a place of honor, and at NSF we really appreciate that.

Senator BURNS. To enlighten everybody else, they have been very instrumental in the Museum of the Rockies, which is connected to the Montana State University, where we have a Rex, and I am not going to go over the dinosaurs, whatever, or Taurus the Bull, or anything else.

Maybe our Speaker of the House will show quite a lot of interest in this. I have never been able to dig much meat off the bones that they are digging out of the ground, and I am kind of a meat and potato guy.

So we appreciate the work that Dr. Jack Horner has done out there in that respect, and we appreciate you.

Senator Rockefeller, I am sorry we got off on this tangent here.

Senator ROCKEFELLER. No. No. That was highly entertaining. [Laughter.]

Senator BURNS. It did not solve anything, but it was entertaining.

Senator ROCKEFELLER. Dr. Lane, I have two questions for you, sir.

Dr. Gibbons, maybe the second one could also go to you.

In the beginning, it is my understanding that you, Dr. Lane, were rather skeptical about the EPSCoR——

Dr. LANE. That is correct.

Senator ROCKEFELLER [continuing]. Program, and that you got involved with a review panel, and that that somehow brought you into a different perception of it.

And I would like to have you take us through that, No. 1. And then second, I want to go back to something which has already been covered, but I want it to be brought forth again. And that is the question that my good friend Conrad Burns mentioned, and the question of industrial policy.

If something is of an industrial policy nature, it would seem to me that the American industry would be the first to complain, or to show skepticism about those programs.

But it is my understanding that they are not doing that, as you said, Dr. Gibbons, that they are able to do things that they simply could not otherwise do without this help. And as you indicated, where we developed programs, and where there is the venture capital program which has not passed, that was in S. 4 in the past Congress, or it is always industry that makes the decision.

They always have the lead position, so that in a sense, it is a partnership, but it is not even really equal partnership.

It is a partnership where the financial decisions, the merit decisions are made by industry, as opposed to government. So those are two questions, one for each of you. I am sorry to extend the panel, but they are important to me.

Dr. LANE. Senator Rockefeller, on the EPSCoR question, you are absolutely right. When I first heard about the program, I thought it was not a good idea. That was 1979, I think, and it turns out that is the year I was at the NSF as division director of physics for a year.

But I had the thought that at a time of constrained funding for research, any kind of fenced program, any program that was not competitive and went head to head with all the other research programs, was suspect, and, therefore, felt this did not sound like a good idea to me. I do not mean I was vocal about it, but that is just the impression I had at the time.

I then was invited a few years later to join a site visit team, going to an EPSCoR state, and reviewing the progress of the EPSCoR grant there.

I was struck, I think would be fair to say, by a couple of things. One was the degree to which a relatively small investment had pulled together other resources and people who otherwise were not talking to one another about science and technology.

The site visiting team met the Governor, met members of the legislature, other distinguished citizens of the state and of the city where the university was located.

All these important individuals cared deeply about the success of EPSCoR. It was not so much the initial investment, it was the catalytic effect that that investment had on activities surrounding science and technology in the state.

I would not have believed it if I had not seen it, but I have seen it over and over again. That, in my view, is the secret of the EPSCoR program. As I say, we are very happy with the program. Our expectation is that the reviews that are going on will only help us improve the program.

Senator ROCKEFELLER. Thanks.

Dr. GIBBONS. Senator Rockefeller, I think part of the confusion about the so-called industrial policy is that it means different things to different people.

But one of the interpretations of industrial policy, as I understand it, is that somehow that connotes a kind of centrally planned decisions by government about where industry is going, and even putting money on the nose of a particular firm or product.

I think that will be a terrible way to do, quite honestly, but that is not the way we are trying to go with these programs.

What we are trying to do with American industry is to see to it that the public role in supporting our economic future be a diverse set of activities that can be telling, in terms of what they provide for us, not only here and now, in creating jobs, but also for the future.

So we work very hard together on the support of fundamental research. There is no interest group in America more solidly behind the vigorous support of fundamental science by the Federal Government than industry itself. I think all of us understand that.

Industry is very supportive of the notion of public policies that enable them to do their job better, whether it be subsidies through long-term investments that one gets from research and engineering tax credits, or improved regulatory procedures, where they can fulfill regulatory needs, but in a way that is less costly to them.

Through these kinds of partnerships that we have been speaking about this morning, in which the public sector, the public good is lined up with the private good, and you co-join in a true partnership effort, whether it be the clean car ideas, or improved construction, or the manifold of things that are coming out of the Federal labs, where, again, it is a mutual self-interest, and all of these are being very carefully couched on the conditions that it be industry led.

But the government has its role in also identifying the public sector return. If it is not there, then the government money will not go into it.

And I think these have been honed over these recent years, and I believe they hold—the evidence is they hold great promise, although we must remember that they are but one of a set of—a collection of activities that, together, spell out a new kind of relationship of governance of our governance, as a nation, and an economy through industry.

I think it is very promising, other countries are looking at it, they are emulating us, and I believe we are at an opportunity to maintain our lead here.

So I hope, as we said at the outset this morning, that we can continue to look at the facts, measure the outcome, test the system openly and carefully. And I believe when we do so, we will have a very strong opportunity for full bipartisan support of this work in the years ahead.

Senator ROCKEFELLER. Thank you both very much.

And thank you, Mr. Chairman, for your courtesy.

Senator BURNS. Thank you, Senator Rockefeller.

And thank you, Dr. Gibbons and Dr. Lane, for coming this morning. I have a couple of written questions that we may submit for you, and if you would answer those for the committee and for me, if you would, please, at your—we will leave the record open if you want to submit other testimony to this hearing, why, that would be available to you. Thank you for coming this morning.

Dr. LANE. Thank you very much, Mr. Chairman.

Dr. GIBBONS. Thank you very much.

[The questions, with responses, referred to are located in the Appendix.]

Senator BURNS. Our second panel, a very distinguished panel this morning, is Dr. Robert Swenson, who is Vice President of Research from Montana State University, at Bozeman, Montana; Dr. Royce Engstrom, who is Project Director for South Dakota EPSCoR Program, at the University of South Dakota, in Vermillion, South Dakota. He knows where Parker is.

We have Dr. John Saunby, who is Director of Union Carbide Technical Center, at Salem, South Carolina, and Dr. Joseph Danek, who is Executive Director, EPSCoR Foundation, here in Washington.

Gentlemen, if you would come forward, please, we would like to hear from you. [Pause.]

Senator BURNS. Thank you very much, gentlemen, for coming this morning. We will just take you in order here.

Dr. Swenson, welcome, and we appreciate you being here this morning.

Dr. SWENSON. Thank you. Do you mind if I defer to my colleague?

Senator BURNS. No. You may yield to anyone that you would like to.

Dr. SWENSON. Thank you.

STATEMENT OF DR. JOSEPH G. DANEK, EXECUTIVE DIRECTOR, EPSCoR FOUNDATION

Dr. DANEK. I believe I am the one that comes first, because what I am going to do, sir, is provide an overview of the EPSCoR program. We will then discuss specific examples from particular states that are represented here today.

Senator BURNS. OK, Dr. Danek. Thank you.

Dr. DANEK. Thank you.

Mr. Chairman, Senator Rockefeller, thank you very much for the opportunity to appear here today to talk about the EPSCoR program. I also want to thank you for your long-standing support of the ESPCoR initiative and for your support of the states that participate in the program.

I am Joseph Danek, Executive Director of the EPSCoR Foundation, a newly established, nonprofit 501(c)3, organization to advance science and technology in the EPSCoR states. [Slide 1.]

Dr. DANEK. The EPSCoR program, which is shown on the slide, stands for the Experimental Program to Stimulate Competitive Research.

The basic objective of the program is to develop the science and technology capability of states that traditionally have been the least competitive for Federal research funds. The program started in 1979 in response to congressional concern over the uneven geographic distribution of Federal research funds in this country.

If I might have the map, please. [Slide 2.]

Dr. DANEK. As shown in the map, 18 states and Puerto Rico participate in the EPSCoR program. These states—designated as the EPSCoR states—receive the least amount of Federal funds among

all states in the country. It is estimated that approximately 7 percent of the total amount of Federal R&D funds awarded to universities and colleges on an annual basis is awarded to the EPSCoR states. That is a little less than 7 percent of the NSF budget, annually.

Senator BURNS. Are the red ones the ones that receive the least?

Dr. DANEK. All of those states receive the least amount of Federal funding.

The red ones are the first states that were entered into the program, in 1980.

Senator BURNS. I see. OK.

Dr. DANEK. The colors show the date of entry into the program. The EPSCoR program is a state and Federal partnership that is designed to increase competitiveness of individual scientists for Federal funds.

It has had remarkable achievements. It has been successful and productive in many ways, because of the fact that EPSCoR has, at its very core (1) rigorous standards; (2) high achievement; and (3) broad-based support across the states.

I might add that part of this success can be attributed to the very constructive and proactive management on the part of the National Science Foundation in working with EPSCoR states under this program. I would like to commend Dr. Lane, Dr. Williams, and their staff.

In 1991, the Congress, after reviewing the EPSCoR program, extended the program to several other Federal agencies. The six agencies—as shown in the box on the far right—that now have EPSCoR initiatives are: the Department of Agriculture (USDA), the Department of Defense (DoD), the Environmental Protection Agency (EPA), the Department of Energy (DoE), the National Aeronautics and Space Administration (NASA), and the National Institute of Health (NIH). The total approved for those programs in FY 1995 was $81 million.

The Administration's request for FY 1996 is $45 million, a 44-percent reduction in the EPSCoR program account across the agencies.

To put this in perspective, the EPSCoR program total across the agencies of $45 million represents less than one-half of 1 percent of the total Federal investment in R&D. And within the NSF, it represents about 1 percent of the NSF budget.

Now, to put this in further perspective, I would like to give you a few facts about the distribution of the R&D across the country.

Just three facts: (1) In 1992, Johns Hopkins University and MIT received almost as many Federal dollars for research than universities in the 18 EPSCoR states and Puerto Rico combined; (2) the top 10 non–EPSCoR states received about two-thirds of all Federal funds for research and development to universities and colleges. The 18 EPSCoR states and Puerto Rico received about 7 percent; and (3) the Administration's request for EPSCoR in FY 1996, as I indicated before, is $45 million. Seventy separate non–EPSCoR universities in this country each received more R&D funds than $45 million last year. [Slide 3.]

Now, the geographic distribution issue and the concern that we are discussing here today via the EPSCoR program—developing the S&T capabilities across the country—is not new.

IN fact, it can be traced to the initial debate over the purpose of the National Science Foundation between 1945 and 1950. I think it is very interesting to note just a few things.

The debate occurred primarily between Vannevar Bush and Senator HARVEY KILGORE. Vannevar Bush, who wrote "The Endless Frontier," the document from which the NSF traces its origin, favored using existing centers of excellence to carry out the goals of the NSF.

Senator Kilgore from West Virginia, who actually first proposed a new science aganecy and called it the National Science Foundation, wanted to use the NSF to build a greater capability across the nation.

In fact, Senator Kilgore's proposal for the NSF would have required that the NSF provide 25 percent of its funding first on the basis of population and then allocate the remaining percent on the basis of scientific merit. [Slide 3.]

The issues that we are discussing today are clear evidence that the debate that framed the initial part of the foundation and its origin is still relevant today.

EPSCoR is a Federal/state partnership. I would like to change it.

It is a state/Federal partnership, because it is directed at achieving the goals of the state. It is the states that determine the areas that are going to be developed and those activities that will be supported.

EPSCoR seeks systemic change by asking states to create a clear vision for science and technology that values academic research. It asks for a strong commitment from the state leadership to use EPSCoR as a catalyst for change.

And it is based on a very strong and competitive plan for developing research that links education and technology development. Its final characterstic is that it is based on significant achievements. [Slide 5.]

The achievements of the EPSCoR program will be discussed in more detail by my colleagues here. But suffice it to say,

EPSCoR has had dramatic and measurable results in a number of areas. It is strengthening academic research; building the scientific infrastructure; creating partnerships; developing human resources and advancing technology transfer within the states. It has been a sound investment in America. [Slide 6.]

Dr. DANEK. As you consider the FY 96 budget for NSF and the future of EPSCoR in developing science & technology, the Foundation offers the following recommendations. The first is that we would ask you to revise the NSF Act to strengthen the mandate of the NSF to develop the science capability in all states, including the EPSCoR states.

Second, we would ask that you recommend the creation of further incentives to mainstream EPSCoR research groups and clusters into the mainstream NSF and other Federal agency programs that were talked about today by Dr. Gibbons and Dr. Lane.

Third, we would ask that you further develop human resources in the EPSCoR states through the creation of traineeship programs

that are shared between the Research Directorates and the EHR Directorate.

We would ask you to consider raising the base Systemic Improvement Award under the EPSCoR program from what is a maximum now of $1.5 million per state to up to $3 million per state per years. [Slide 7]

Fourth, a Federal-wide level, we would ask that you look at the Federal-wide programs and to recommend the establishment of a stable core of programs in the agencies noted. We ould also recommend the establishment of an EPSCoR-like program within the Department of Commerce and to use the EPSCoR developed research expertise and human capital to strengthen the private sector, through a technology development program within the Department of Commerce for the EPSCoR states.

And finally, we would ask the Office of Science and Technology Policy to take a more active role, as what Dr. Gibbons was talking about this morning, in integrating the EPSCoR program into the many issues that the government deals with and in which it sets its priority for the future and the future of one-third of the nation, the EPSCoR states. [Slide 7B.]

I thank you for the time today.

Senator BURNS. Thank you, Dr. Danek.

[The prepared statement of Dr. Danek follows:]

Testimony of
Dr. Joseph G. Danek

Executive Director
EPSCoR Foundation

before the

U.S. Senate
Subcommittee on Science, Technology, and Space
Committee on Commerce, Science, and Transportation

The Honorable Conrad Burns
Chairman

March 30, 1995

Testimony of
Joseph G. Danek
Executive Director
EPSCoR Foundation

before the
U.S. Senate
Subcommittee on Science, Technology and Space
Committee on Commerce, Science and Transportation
The Honorable Conrad Burns, Chair

March 30, 1995

I. INTRODUCTORY COMMENTS. I wish to thank the members of the Subcommittee for the opportunity to appear before you today as well as for your on-going support of the EPSCoR initiative. I also want to express appreciation to NSF Director Neal Lane and Assistant Director Luther Williams for their continued support as well.

I am Joseph G. Danek, Executive Director of the EPSCoR Foundation, a non-profit, 501 (c) 3 organization dedicated to the advancement of science and technology (S&T) in the 18 EPSCoR states and the Commonwealth of Puerto Rico.

EPSCoR stands for the "Experimental Program to Stimulate Competitive Research." Its name conveys clearly its goal: to stimulate better research in underfunded states and increase the ability of scientists in these states to compete for Federal research support. The National Science Foundation (NSF) created EPSCoR in response to concerns about the uneven distribution of Federal support for university-based research and development (R&D).

II. FEDERAL R&D DISTRIBUTION. Few things in the United States are as highly concentrated as Federal R&D support to universities and colleges.

Let me start with a few facts about the distribution of these funds to put the present EPSCoR initiative in perspective for you.

- In 1992, the government awarded almost as many Federal dollars for research and development to Johns Hopkins University and MIT as it awarded to all universities in the 18 EPSCoR states and Puerto Rico, combined .
- On a state level, 10 states received about two-thirds of all Federal R&D support to universities and colleges; the 19 EPSCoR states received about 7%.
- In 1992, 70 universities each received more than $45 million in Federal R&D funds. This is more than the Administration has requested in fiscal year (FY) 96 for the entire Federal-wide EPSCoR initiative.

III. BACKGROUND. The NSF honors Vannevar Bush as its founding father. His famous report *Science the Endless Frontier* is the document from which the Foundation traces its origin.

But in doing so, we slight Senator Harley M. Kilgore of West Virginia who held ideas quite different from Bush's about the purpose of NSF. Senator Kilgore first proposed the creation of a new Federal science agency during World War II, and he called it the National Science Foundation.

Four issues were at the heart of the debate between Vannevar Bush and Senator Kilgore:

- Bush favored a focus on the natural sciences; Kilgore believed that the social sciences were equally important.

- Bush favored research to develop knowledge for its own sake; Kilgore sought to use new knowledge for the social good.

- Bush favored control of the Foundation by the scientific community; Kilgore favored broader input.

- Bush favored using existing centers of excellence; Kilgore wanted to use the Science Foundation to build greater capability across the nation.

In fact, Senator Kilgore's proposal for the NSF required that 25 percent of the Foundation's annual budget be allocated to the States geographically (two-fifths in equal shares and three-fifths on the basis of population). The remaining 75 percent could then be allocated through the national merit review process.

In 1978, in hearings similar to today's, the House and the Senate again debated the issue of the importance of developing scientific and technical talent nationwide. The idea of allocating a portion of the NSF funds on a geographic basis was discussed again. In response, the Foundation initiated the EPSCoR program.

This hearing today is further evidence that the issues that framed the debate about the purpose of the NSF almost 50 years ago continue to be relevant today. These issues, such as idea-based versus technology driven research, the proper mix of scientific freedom and political direction and the geographic distribution of capability continue to stir controversy over what is best for America.

The NSF established EPSCoR in 1979 in response to concerns about the uneven geographic distribution of Federal support for university research and development. EPSCoR is designed to stimulate better research in underfunded states and increase the ability of scientists in these states to compete for Federal research support.

In 1990, after reviewing the results of the NSF experiment, Congress began expanding EPSCoR beyond NSF. Today, EPSCoR is a set of competitive, merit-based programs at seven Federal agencies: the National Science Foundation; the Departments of Agriculture (USDA), Energy (DOE) and Defense (DOD); the Environmental Protection Agency (EPA); the National Aeronautics and Space Administration (NASA); and the National Institutes of Health (NIH).

Eighteen states and the Commonwealth of Puerto Rico now participate in the NSF EPSCoR program. Eligible participants include: Alabama, Arkansas, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, North Dakota, Oklahoma, South Carolina, South Dakota, Vermont, West Virginia, Wyoming and the Commonwealth of Puerto Rico. The attached map shows the point of each state's entry into the program from 1980 through 1992.

The Administration's FY 96 request for all EPSCoR programs is $45.3 million, a 44% reduction from last year's appropriated level. Let me re-emphasize that....a 44% reduction. The NSF portion of this is $35 million - down $1 million from FY 95.

IV. THE EPSCoR CONCEPT. EPSCoR represents a Federal-State partnership to enhance the science and engineering research, education, and technology capabilities of states that traditionally have received smaller amounts of Federal R&D funds. Through EPSCoR, participating states are building an academic research base that will serve as the backbone of a strong scientific and technological (S&T) enterprise.

Two types of awards are made under EPSCoR: Systemic Improvement (SI) cooperative agreements and smaller one to three year non-renewable Experimental Systemic Initiative (ESI) grants. The EPSCoR SI awards are three year, cooperative agreements that total up to $1.5 million annually to each State. These awards seek systemic and sustainable change. Systemic change in EPSCoR means permanent changes in the S&T enterprise in participating states and is marked by:

- a clear State vision for S&T that values competitive academic research;
- a commitment to use EPSCoR as a catalyst for change; not just a research grant;
- a locally relevant high quality implementation plan;
- a plan that links education, research and technology development and creates productive partnerships across all sectors; and,
- significant achievements.

V. EPSCoR ACHIEVEMENTS. As you will hear from my colleagues, ESPCoR has demonstrated dramatic and measurable effects on individual researchers, institutions and the overall scientific and technical capability of the States.

- **EPSCoR strengthens academic research.** EPSCoR empowers individual scientists and research teams who can become competitive by national standards.

EPSCoR does not support individual scientists or groups who are already fully funded in the regular "mainstream" Federal research programs. EPSCoR is dedicated to enhancing capability.

Individuals and teams of researchers seeded with EPSCoR funds have gone on to win awards from mainstream Federal, state and private sector research programs and they have "graduated" from EPSCoR.

- **EPSCoR coalesces leaders and builds the S&T infrastructure for the future.** In addition to the development of individual researchers and groups, broader-based systemic improvements in the S&T environment are being made in EPSCoR states to retain and attract talented students, scientists and entrepreneurs.

  The heart of EPSCoR is a state-wide committee, composed of leading scientists, university administrators, state officials and representatives of business and industry. The committee is responsible for: (1) designating the areas to be developed and formulating the multi-year EPSCoR plan for the state; (2) coordinating the state effort under EPSCoR; (3) exercising quality control through the use of external reviewers; and (4) ensuring that the research supported under EPSCoR is consistent with state economic and human resource development goals.

  EPSCoR committees serve as catalysts for systemic change. Increased cooperation and the development of successful ventures across the S&T sectors has been a hallmark of EPSCoR. EPSCoR leaders play key roles in stimulating systemic reform in graduate, undergraduate and K-12 science and mathematics and technology education. Early agreements among institutions to work as a team, forged under EPSCoR in the 1980s, positioned the EPSCoR states to compete favorably for Federal educational systemic reform awards in a number of agencies.

- **EPSCoR develops human resources**. EPSCoR recognizes that talent is distributed widely across the Nation. It is found in schools, towns, universities, and small firms across America. EPSCoR helps to identify and develop talented people—providing the resources and the climate for talent to flourish. While the epicenter of EPSCoR is faculty research, the quality of undergraduate and graduate education is a high priority. EPSCoR provides opportunities for students to be involved in high-quality research.

- **EPSCoR enhances technology transfer and economic development**. EPSCoR states know that they cannot maintain a vibrant S&T enterprise without using their EPSCoR enhanced research base to develop, attract, and retain high technology

companies. Residents of EPSCoR states know that these companies will provide the jobs that will keep—and bring—bright students, researchers, and entrepreneurs home. EPSCoR is a research development program, but it is relevant to the people in the States and the development of a strong technological base uniquely suited to each State.

- **EPSCoR is a sound investment in America's future**. EPSCoR has been the cornerstone of science and technology development in the 18 EPSCoR states and the Commonwealth of Puerto Rico. From increasing our knowledge of dinosaurs that roamed the EPSCoR states over 65 million years ago to developing new processing techniques for wooden bridges and seminal discoveries critical to the development of low temperature superconductivity, EPSCoR has made its mark on America for what has been a very small investment. Over the first decade of EPSCoR for every $1.00 of Federal funds the states have invested $2.50 of their own funds.

  EPSCoR remains a sound investment in America's future but it requires greater effort and support within NSF and across the Federal government.

VI. RECOMMENDATIONS FOR THE FUTURE. EPSCoR has a strong merit-base. It has been remarkably productive and it has stimulated systemic change. We commend the NSF for their very fine efforts to date under this program.

But EPSCoR in its current form is not sufficient to reverse the current concentration of science and technology capability. We believe it unwise for the nation to focus its resources only in existing centers of excellence. Federal R&D policy must recognize that the American scientific community is comprised of young children, science and math teachers, faculty, universities and small and large technology-based firms located across America.

The EPSCoR Foundation urges this Subcommittee to:

(1) Revise the National Science Foundation Act of 1950, as modified, to strengthen the mandate of the NSF to develop, over the next decade, the scientific and technical capabilities of all States, including the EPSCoR states.

(2) Recommend that a "core" EPSCoR program be a permanent part of the portfolio of the DOD, DOE, NASA, USDA, EPA, and NIH. Each year, Congress adds funds for EPSCoR and as a rule the agencies request less or delete the program from subsequent budget requests.

(3) Require the Office of Science and Technology Policy (OSTP) to play a stronger role in coordinating and sustaining a viable Federal-wide EPSCoR initiative. This effort should be coordinated by the National Science and Technology Council (NSTC) and given equal priority with such initiatives as high performance computing and global climate change.

(4) Incorporate, within the NSF, the EPSCoR goals into the performance benchmarks of the NSF Research Directorates. The NSF should maintain a "core" EPSCoR program. However, funding should be added to the NSF Research Directorates to support "transition" awards to help mainstream promising EPSCoR research clusters and to move selected clusters and groups to the level of nationally recognized research centers. Transition awards should be for up to 5 years with the first 3 years shared equally between EPSCoR and the NSF Research Directorates. Particular attention should be given to state, industry, and university partnerships.

(5) Establish a traineeship program to hold and attract talented students in the EPSCoR states, with shared responsibility between the EPSCoR program and the NSF Research Directorates.

(6) Increase the base NSF EPSCoR Systemic Improvement award from a maximum of $1.5 million per year to up to $3 million per year. This is consistent with other NSF centers and the Foundation's Educational Systemic Reform Initiatives.

(7) Establish an EPSCoR-like initiative that is oriented toward "technology development" in the EPSCoR states within the Department of Commerce to complement the NSF EPSCoR program which is targeted primarily on competitive university-based research.

(8) Create an EPSCoR Future Fund, using the State of South Dakota's Future Fund as a model, to finance a comprehensive Federal-wide EPSCoR initiative. This Future Fund could be financed from savings generated by the "Reinventing Government" Initiative and other efforts to reduce Washington-based government.

We propose that this Subcommittee direct the NSF to explore, in partnership with the EPSCoR states, the feasibility and potential effectiveness of an EPSCoR Future Fund financed from "small percentages" of the savings garnered from revised and streamlined Federal programs.

It is this kind of bold and visionary leadership that we believe the Electorate is looking for. It would enable the Nation to move toward Senator Harley Kilgore's dream of deploying science and technology to benefit the entire nation, and assuring an efficient and effective return on taxpayer dollars. In this way, we would bring an end to the "endless frontier" of underfunded science and technology in one-third of our nation.

(Slide 1 thru 7B)

(Dr. Joseph Danek slides)

***E**xperimental*
***P**rogram to*
***S**timulate*
***C**o mpetitive*
***R**esearch*

(Slide 2)

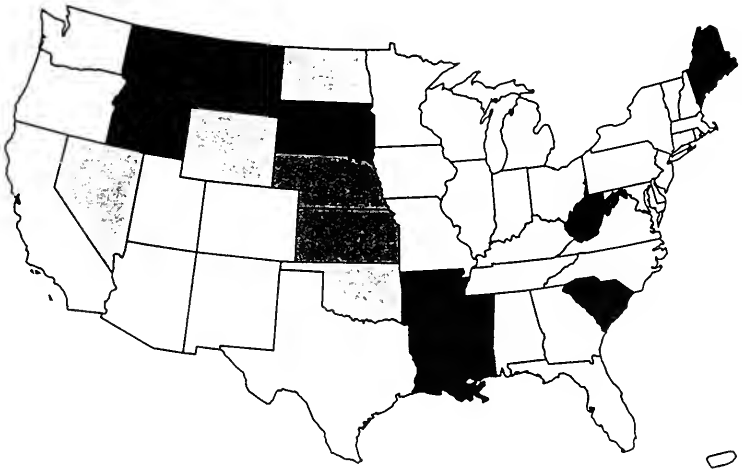
EPSCoR States by Year of Program Entrance

FY 1980
Arkansas
Maine
Montana
South Carolina
West Virginia

FY 1985
Alabama
Nevada
Oklahoma
Vermont
Kentucky
North Dakota
Puerto Rico
Wyoming

FY 1989
Idaho
Louisiana
Mississippi
South Dakota

FY 1992
Kansas
Nebraska



		$ Millions	
EPSCoR Entrance	Agency	FY95	FY96
1980	NSF	37	36
1991	USDA	10	-0-
	DOD	20	-0-
	EPA	1	-0-
	DOE	7	2.4
1992	NIH	1	1
1993	NASA	5	6
	Total	81	45.4

(Slide 3)

FEDERAL R&D DISTRIBUTION

- In 1992 Johns Hopkins University and MIT received almost as many Federal dollars for research than all universities in the 18 EPSCoR states and Puerto Rico, combined.

- 10 top non-EPSCoR states received about two thirds of all Federal R&D support to universities and colleges; the 18 EPSCoR states and Puerto Rico received about 7%.

- The Administration request in FY96 for the entire Federal-wide EPSCoR initiative is $4.5 million; 70 separate non-EPSCoR universities each received more R&D funds than this last year.

(Slide 4)

VANNEVAR BUSH VS. SENATOR HARLEY KILGORE

- Bush favored the natural sciences; Kilgore believed that the social sciences were equally important.
- Bush favored research to develop knowledge for its own sake; Kilgore sought to use new knowledge for the social good.
- Bush favored control of the Foundation by the scientific community; Kilgore favored broader input.
- Bush favored using existing centers of excellence; Kilgore wanted to use the Science Foundation to build greater capability across the nation.

(Slide 5)

THE EPSCoR CONCEPT

EPSCoR REPRESENTS A STATE-FEDERAL PARTNERSHIP

- **EPSCoR seeks systemic change. This includes the following:**
  - **a clear State vision for S&T that values competitive academic research;**
  - **commitment to use EPSCoR as a catalyst for change;**
  - **a plan that develops research, links it to education and technology, and creates partnerships; and**
  - **significant achievements**

(SLIDE 6)

EPSCoR ACHIEVEMENTS

- EPSCoR strengthens academic research
- EPSCoR coalesces leaders and builds the S&T infrastructure for the future
- EPSCoR develops human resources
- EPSCoR enhances technology transfer and economic development
- EPSCoR is a sound investment in America's future

(Slide 7a)

EPSCoR: Recommendations for the Future

I. National Science Foundation

- Revise NSF Act: Strengthen mandate of NSF to develop S&T capabilities of EPSCoR states
- Create incentives to "mainstream" EPSCoR research groups and clusters
  - (a) Increased recognition and support within the NSF Research Directorates
  - (b) Create "transition" awards to mainstream EPSCoR groups into NSF Research Directorates programs
- Establish Traineeship Initiatives shared by EPSCoR and the Research Directorate

(Slide 7b)

EPSCoR: Recommendations for the Future

II. Federal-Wide

- Recommend stable "Core" EPSCoR initiatives in DoD, DoE, NASA, USDA, EPA, NSF, and NIH
- Establish EPSCoR in the Department of Commerce to use EPSCoR developed research expertise and human capital to strengthen the private sector and economy in the states.
- Require OSTP to take more active role in coordinating and sustaining EPSCoR.

SOUTH DAKOTA EPSCoR

REACH: RESEARCH EXCELLENCE A CRITICAL HALLMARK

- A PARTNERSHIP
- HIGHLY FOCUSED SCIENCE AND INFRASTRUCTURE DEVELOPMENT
- HUMAN RESOURCE AND EDUCATION
- AN INVESTMENT

MONTANA EPSCoR SUMMARY

- EPSCoR is working in Montana
- A relatively small amount of Federal funding is having a disproportionate positive impact on research, education, and technology deployment.
- It is a sound investment in the future of Montana, and therefore the nation.
- However, it is only a start and the state still has a long way to go, but the changes are in the right direction.

MONTANA EPSCoR

- The primary purpose of EPSCoR is to serve as a change agent and enabler to develop research competitive scientists and programs.

- The quality of an undergraduate education is critically dependent on the quality of the faculty and equipment and the opportunity to become engaged in creative activities in partnership with a faculty member and graduate students.

CONCLUSION #1

EPSCoR is facilitating the growth of competitive science and the improvement of the quality of education

MONTANA EPSCoR

- 98% of Montana businesses have fewer than 50 employees
- 80% of Montana businesses have fewer than 10 employees
- Nationally industries spend $5.14 on R&D to $1 at universities
- In Montana, it is just reversed, as universities spend $6.40 on R&D to $1 by private sector

CONCLUSION #2

Businesses and industry in Montana do not have the human or capital resources to do research or to employ sufficient numbers of individuals who are knowledgeable on recent research findings and can effect appropriate technology transfer and application

MONTANA EPSCoR

- NSF EPSCoR facilitated the development of linkages and partnerships
- NSF EPSCoR caused the creation of the Montana Science and Technology Alliance and the development of the State's "Science and Technology Plan" and the "S&T Action Agenda"
- Universities have responded to the Action Agenda and created programs which work with industry

Conclusion #3

Universities in "non-industrial" states have a unique role to play...they are the research, modern facilities, and technology transfer arms of the private sector. NSF EPSCoR has supported and enabled these activities in Montana.

BENEFITS FROM EPSCoR IN WEST VIRGINIA

- Improved ability to attract and retain outstanding scientists
- University research targeted toward needs
- Broadened knowledge of, and interest in, science & technology
- Increased interaction between universities & colleges
- Increased interaction between universities, industry and state government
- Increased research funding
- Vehicle for science & technology strategic planning available

EPSCoR IN WEST VIRGINIA

Issues:

- Stability of EPSCoR programs - ability to "transition" investigators and groups in time frame of EPSCoR funding
- Matching funds - especially as the non-research component of the program increases
- Support for basic vs applied research
- Industrial linkage

Recommendations:

- Continue EPSCoR programs with increased emphasis on centers for advanced technology
- Increase size and duration of grants, subject to acceptable performance against milestones

West Virginia EPSCoR
State Advisory Committee

Richard Bajura Director, National Research Center for Coal and Energy	Mark Lowdermilk WV Development Office	Jack deBarbadillo (Chair) INCO Alloys Int
Robert C. Gillespie WV Institute of Technology	Paul W. Jagodzinski Chemistry Department West Virginia University	Laura Kuhns McCabe-Henley
Thomas F. Lemke (ex officio) INCO Alloys Int	Lee W. Rivers National Technology Transfer Center	John Saunby (ex officio)
Tom Storch College of Science Marshall University	Parvez Wadia Union Carbide Howard Aulick School of Medicine Marshall University	Frank Calzonetti (ex officio) EPSCoR Program Director

Senator BURNS. Dr. Engstrom, we will go with you, from South Dakota.

STATEMENT OF DR. ROYCE C. ENGSTROM, PROJECT DIRECTOR, SOUTH DAKOTA EPSCoR

Dr. ENGSTROM. Thank you, Chairman Burns, Senator Rockefeller. Thank you for the opportunity to testify about EPSCoR here this morning.

I am Royce Engstrom. I am a professor of chemistry at the University of South Dakota. I am the project director for South Dakota EPSCoR right now.

I am especially pleased to discuss EPSCoR with you, because I feel it has been the most important thing that has happened to science and technology in South Dakota for several decades.

We entered the program as recently as 1989, so we are one of the newer states that has come into EPSCoR. I feel that EPSCoR has been especially effective in South Dakota because of its unique design.

There really is not any other program around that encompasses the breadth of development that EPSCoR does.

I would like to illustrate that with four points with some illustrations that are specific to South Dakota.

If you could put the first overhead up there. [Slide.]

Dr. ENGSTROM. The first point that I would like to make is that EPSCoR is a partnership program. In South Dakota, the National Science Foundation has invested $5.3 million over the last 6 years. The state has invested $10.7 million. So the state commitment has been in a two-to-one ratio.

In fact, in South Dakota, we established something called the South Dakota Future Fund especially to do this. It is administered out of the Governor's Office of Economic Development, in recognition that basic research impacts economic development in the state.

EPSCoR is also a partnership program at the level of institutions. We have cooperations between the University of South Dakota, South Dakota State University and the South Dakota School of Mines.

Those three institutions are cooperating at unprecedented levels to make EPSCoR work. Our state-level steering committee has representation from higher education, state government, the private sector and external consultants to South Dakota.

Finally, EPSCoR is a partnership program at the level of the faculty who are making it work. We have a physiologist on our campus, for example, collaborating with an animal scientist at South Dakota State.

The two have published their first paper together, and that is a collaboration that would not have happened without EPSCoR.

The second major point is that EPSCoR is focused. It is highly focused on specific research areas and on the development of infrastructure, and that is what really makes EPSCoR unique.

The research areas in South Dakota and in all of the states are basically chosen on several criteria. One, we try to identify the expertise that we have in the state; and, two, we try to identify areas that ultimately can impact economic development, through the suc-

cess of additional independent grant funding and ultimately to technology transfer activity.

So in our state we emphasize areas of chemistry, the life sciences, and a new focus will be environmental imaging, making use of the EROS Data Center north of Sioux Falls.

The infrastructure development activities in the states are really what make EPSCoR unique, because it is building for the future. Again in our state, we have emphasized development of new faculty, the development of graduate programs, acquisition of instrumentation that gives us the tools that other competitive states have, and communication between scientists.

Just as an example, one of our new faculty that we hired through the EPSCoR program, in her first year went out and got a $500,000 independent grant from NSF and NASA. So she is typical of the kind of investment we have been trying to make.

The third major point is that EPSCoR focuses on human resource development. South Dakota and most of the EPSCoR states are EPSCoR states because they simply do not have the personnel base that other, bigger states do.

And so we work hard at education and getting people involved in science at all levels. We have faculty development programs, graduate student, undergraduate, high school teacher program, high school student programs, and programs that involve 4-year college teachers.

A few quick examples: John Kellar is a new faculty member at the School of Mines, and he has become South Dakota's first Presidential Faculty Fellow, a prestigious award by the National Science Foundation.

Scott Andryski is an undergraduate student who has been involved EPSCoR research since he was a freshman at the University of South Dakota. He is going on to California——

Berkeley for his Ph.D. now.

Julie Heaton is a woman in my research group, a mother of two, who, prior to EPSCoR, would not have been able to undertake a Ph.D. program in South Dakota.

But because of a special cooperative arrangement between South Dakota State and the university that has been put in place because of EPSCoR, she will be able to stay in the state and get her Ph.D.

Finally, EPSCoR has been an investment in South Dakota.

Senator ROCKEFELLER. I did not understand that. It sounded like a very interesting example, but I did not catch how you overcome the problem of having two children.

Dr. ENGSTROM. OK. I am sorry. She is located in Vermillion and has a family there with other obligations. In Vermillion, we do not have a Ph.D. program in her area at the University of South Dakota.

We do at South Dakota State, though, 100 miles away. We now put in place a cooperative arrangement between those two schools that will allow her to work on her Ph.D. located in Vermilion, but get the Ph.D. from South Dakota State University.

Senator ROCKEFELLER. I understand. Thank you.

Dr. ENGSTROM. Thank you.

Last, EPSCoR in South Dakota, in all of the states, of course, has been an investment. And I would just like to show you how it has been paying off with two quick overheads. [Slide.]

Dr. ENGSTROM. One, the total grants and contracts at the three universities in South Dakota involved in EPSCoR has increased from a relatively flat baseline prior to the EPSCoR years.

The 3 years at the end there are the years after EPSCoR stated. There is a 1-year delay, but those are the years after EPSCoR has been put in place. So significant increases in the independent grants and contracts activity.

And then on the last overhead are our faculty investigators. Their productivity, as measured by scientific publications and independent grant applications, has been increasing steadily during the EPSCoR years, as well.

So EPSCoR has played a crucial role in South Dakota. It has allowed South Dakota to become a bigger part of the nation's scientific and technology enterprise. And we appreciate the support of the National Science Foundation.

Thank you.

[The prepared statement of Dr. Engstrom follows:]

Testimony of
Dr. Royce C. Engstrom
Project Director
South Dakota EPSCoR

before the
Subcommittee on Science, Technology and Space
Senate Commerce, Science and Transportation Committee

March 30, 1995

South Dakota is among the more recent States to enter the EPSCoR program, with funding beginning in 1989. EPSCoR has been one of the most important factors in the past several decades of science and technology in South Dakota, and has contributed more to the development of science and technology in the State than any other single program in our history. The following points describe the uniqueness of the EPSCoR program in South Dakota and emphasize the impact it has had on the State.

One of the most important features of the EPSCoR program is that it is a partnership program. During the history of South Dakota EPSCoR, the National Science Foundation has invested a total of $5.3 million, which has been matched by $5.1 million of State funds and $5.6 million from the institutions of higher education. In South Dakota's case, every federal dollar has been matched with more than two dollars of non-federal funds. As a result of EPSCoR, the State established the South Dakota Future Fund for the purposes of providing seed money for economic development. Recognizing that university research could contribute substantially to economic development, EPSCoR has been one of the primary activities funded through the Future Fund. It is significant that revenues to the Future Fund are derived from businesses within the State.

EPSCoR is a partnership program at the level of the participating universities as well. In South Dakota, the three research institutions, the University of South Dakota in Vermillion, South Dakota State University in Brookings, and the South Dakota School of Mines and Technology in Rapid City, have worked together to design the EPSCoR program and to implement its many facets. Never before has there been a project of this magnitude that has brought the three schools together toward a common goal. A State-wide steering committee, consisting of university administrators, State government officials, private sector representatives and consultants from outside of South Dakota, has worked to create and guide the program from its inception. The steering committee in South Dakota is called the REACH (Research Excellence: A Critical Hallmark) Committee.

Partnerships continue at the level of the faculty scientists. For example, a physiologist from the University of South Dakota is collaborating with an animal science faculty

member from South Dakota State University because of the EPSCoR program, and they just recently published their first scientific paper together. Likewise, metallurgists from the South Dakota School of Mines and Technology are working with chemists at the University of South Dakota to study corrosion processes using instrumentation that neither school has by itself. In fact, all of the scientific research carried out within the EPSCoR program is interinstitutional, involving scientists from all three campuses.

EPSCoR is a highly focused program. Two areas of development operate in the South Dakota EPSCoR program. One of these involves specific research efforts which will increase the State's research competitiveness in the near-term, and one involves the development of the science and technology infrastructure within the State to insure long-term competitiveness.

The scientific research areas being developed under EPSCoR were selected because (1) they made use of the State's best scientific talent; (2) the areas are important to the national science community, and (3) they represent fundamental research that forms a basis for industries important in South Dakota. Up to this time, EPSCoR has focused on only two areas, one referred to as "Surface and Interfacial Science," and the other as "The Role of Membranes in Cell Regulation." The first has involved approximately 15 faculty scientists and includes projects important to environmental concerns, mineral extraction, corrosion and sensor development. The second involves approximately 25 faculty and includes projects crucial to the agricultural and medical communities. In the upcoming years, a third scientific thrust will be added, "Imaging and Modeling of Coupled Environmental Processes." This group will make extensive use of the EROS Data Center just north of Sioux Falls, a federally-funded facility that processes satellite images of the earth to learn about vegetation coverage, weather patterns, and water resources.

The S&T infrastructure development, part of EPSCoR, puts in place those characteristics which make a university able to compete effectively for independent research funding. In South Dakota's case, infrastructure development has resulted in the following achievements:

- Faculty members in the sciences areas have been increased by nine positions, and EPSCoR has resulted in the hiring of excellent young scientists who are quickly establishing themselves within the national scientific community.

- Top notch graduate students are coming to South Dakota to pursue advanced degrees because of increased recruiting efforts funded by EPSCoR.

- State-of-the-art scientific instrumentation has been purchased, providing South Dakota scientists with the same type of equipment that scientists in more competitive States have access to.

- Communication among scientists, between scientists and the general public, and between scientists and State officials has been enhanced. South Dakota scientists now routinely communicate with colleagues across the country and with one another over the Rural Development Television Network. A South Dakota Public Television series is being prepared for the general public about research in South Dakota and its importance to South Dakota's future.

EPSCoR focuses on human resource development and education. The EPSCoR program has provided opportunities for many South Dakotans at all levels. Certainly, it has helped our faculty gain national status. A prime example of that is Jon Kellar, a young engineering faculty member at South Dakota's School of Mines and Technology, who was recently recognized as South Dakota's first Presidential Faculty Fellow based largely on the work he was able to initiate through EPSCoR support.

EPSCoR provides opportunities for more than just faculty, however. Graduate students, undergraduates, high school students, high school teachers, and four-year college faculty have all participated in the project. While many people may view research as being divergent education, nothing could be farther from the truth. In the EPSCoR States, research provides an environment in which faculty and students come together in a one-on-one setting, formulating questions, designing experiments and analyzing results. Problem-solving skills are developed, communication skills are honed through presentation and publication, and interpersonal relationships are developed which will benefit students in their professional careers.

An especially powerful collaboration exists between South Dakota EPSCoR and another National Science Foundation program, the Statewide Systemic Initiatives in Science and Mathematics Education (SSI). High school teachers have spent ten weeks during the summer months in the laboratories of EPSCoR investigators. They take the new knowledge they have gained back to their classrooms, along with an allocation that provides equipment and supplies they need to initiate new curriculum in their schools. In particular, teachers from the Native American community have participated. Bradley Beck, a teacher from Leola, SD, wrote, "I am proud to say that some of the work I did over the past two summers is being used in a paper that Dr. Washburn is submitting. The experience has increased my knowledge of microbial genetics, which I hope to pass on to my students."

Undergraduates from the three universities as well as other colleges in the State have also participated in EPSCoR projects during the summer months. Many of these students have gone on to give presentations at the National Conference on Undergraduate Research, for example, and have become co-authors of scientific

publications, an attribute that places them in high demand for employment or further graduate study.

For example, Scott Andryksi and Jennifer Shumaker are students who have been involved in EPSCoR sponsored research since their first year in college, and are now entering graduate school at U. of California - Berkeley, and North Carolina - Chapel Hill, respectively.

As a result of EPSCoR in South Dakota, students have more opportunities for graduate study in sciences with recently instituted graduate programs in chemistry, biology and atmospheric sciences. For example, Julia Heaton, a bright student with a family, is planning on starting her Ph.D. program in a cooperative agreement between South Dakota State University and the University of South Dakota next fall. A few years ago, she would not have been able to meet that goal without leaving the State.

EPSCoR is an investment. The EPSCoR program currently amounts to approximately 5% of the total grants and contracts activity of the three research institutions in South Dakota. EPSCoR serves to catalyze further activity. The grants and contracts activity has doubled during the EPSCoR years in South Dakota, scientific productivity in the form of publications and independent grant proposal submissions has increased by a factor of five within the group of EPSCoR participants, and a number of major independent grants have come to EPSCoR participants. Fedora Sutton, for example, recently was awarded a $500,000 joint NSF-NASA grant; Ron Lindahl recently received a $600,000 grant from the National Institutes of Health; and Ken Han has had a patent approved which has formed the basis for a new company in Rapid City that performs platinum recovery from spent automobile catalytic converters. All of these achievements were a direct result of EPSCoR.

The highly focused and sustained nature of EPSCoR support is critical to the continued development of science and technology in South Dakota. As a State with relatively little technology-based industry, it is the responsibility of the universities to strengthen their research competitiveness and build a more attractive environment through which the State's economy can continue to diversify. EPSCoR is the cornerstone of technological development in South Dakota, and we strongly support the enhanced program outlined earlier by Dr. Danek.

Senator BURNS. Dr. Swenson.

STATEMENT OF DR. ROBERT J. SWENSON, VICE PRESIDENT FOR RESEARCH AND CREATIVE ACTIVITIES, MONTANA STATE UNIVERSITY AT BOZEMAN

Dr. SWENSON. Chairman Burns, Senator Rockefeller, I appreciate the opportunity to discuss the Montana EPSCoR program with you.

I am Bob Swenson, Vice President for Research. I am Chairman of the State EPSCoR Committee and Vice Chairman of the National EPSCoR Coalition.

I come as one of Aesop's ants. EPSCoR is all about seed corn. It is about linkages in partnerships and relationships. This program is the basis for the development of competitive research.

The competitive research faculty improve the quality of the undergraduate education, and they also provide the basis upon which technology transfer can take place within the state.

A couple of examples of this: Before the EPSCoR program began, the Montana State University grant and contract activity was under $10 million. This year it is going to be over $35 million. That is a substantial increase, which we can attribute largely to the EPSCoR program.

In terms of the quality of undergraduate education and the role research plays, I can cite a couple of facts. The very competitive Goldwater Scholarships, which are awarded to students across the nation, the number of those have been increasing at EPSCoR institutions.

And presently, two EPSCoR institutions, Montana State University and Kansas State University, lead the Nation in the number of awards of Goldwater Scholarships. Harvard is second and Caltech is third.

And I think this is indicative of what our students have been able to achieve as a result of the EPSCoR activities.

So EPSCoR is facilitating the growth of competitive science and improvement of the quality of education in these states.

Second slide, please. [Slide.]

Dr. SWENSON. Next I would like to quote ex–Governor Richard Celeste from Ohio. "Small and medium-sized firms, the ones that cannot afford their own R&D are the biggest customers for the application of new knowledge to products and production processes."

In Montana, we only have small firms.Ninety-eight percent of Montana businesses have fewer than 50 employees, 80 percent fewer than 10, 60 percent fewer than 5. Nationally, industries spend in-house $5 on R&D to every $1 spent in-house at the universities.

In Montana, it is just the reverse. Universities spend nearly $6.50 on research and development compared to in-house research of the private sector of $1.

So my second conclusion is that businesses in states like Montana do not have the capital nor the human resources to do research or to have individuals who have the knowledge to effect appropriate technology transfer.

The next slide, please. [Slide.]

Dr. SWENSON. NSF EPSCoR has facilitated the development of linkages and partnerships within the state among the universities and colleges, the private sector and state and Federal Government.

NSF EPSCoR has caused the establishment in Montana of the Montana Science and Technology Alliance. It is responsible for the development of the State Science and Technology Plan and the State Science and Technology Agenda.

This agenda was put together by eight economic sector groups. They put together a focus document indicating out science and technology can be impacted or can impact on these private sector companies.

Let me quote from the Science and Technology Plan. "There is little history of cooperation and coordination among Montana industries and university programs. There is no consistent process for transfer of intellectual property. That link between basic research at the universities and Montana's economic development must be strengthened."

This was written in 1990, and I am very pleased to be able to report that the universities have responded to this action agenda, and they have created programs, which work with industry on research opportunities, which provide technical and business assistance, which transfer technologies and new product lines and which assist in accessing personnel and facilities at the university.

So the third conclusion to draw is that—and I think this is a very important one when one thinks about Federal policy and agency policy—universities in non-industrial states have a unique role to play, that of research, modern facilities and technology transfer arms of the private sector.

As you discussed earlier about this mix from basic research through applied research through technology development and finally into commercialization, most of the businesses in our states cannot provide that mix, and the universities are the place where that mix takes place.

That has lots to say for different kinds of Federal policies. NSF EPSCoR has supported and enabled these activities in the State of Montana.

The last slide, please. [Slide.]

Dr. SWENSON. So let me conclude by just stating that EPSCoR is working in Montana. A relatively small amount of Federal funding is having a disproportionate positive impact on research, education and technology deployment.

It is a sound investment in the future of Montana and therefore the nation. However, it is only a start, and the states still have a long ways to go. But the changes are definitely in the right direction.

Thank you.

Senator BURNS. Thank you, Dr. Swenson.

[The prepared statement of Dr. Swenson follows:]

Written Testimony

Dr. Robert J. Swenson
Vice President for Research and Creative Activities
Montana State University

Before the
Subcommittee on Science, Technology & Space
Senate Committee on Commerce, Science and Transportation
March 30, 1995

I am Dr. Robert Swenson, Vice President for Research and Creative Activities at Montana State University. I am also the Chair of the Montana EPSCoR Committee and Vice Chair of the EPSCoR Coalition. I am a physicist.

EPSCoR has been and continues to be extremely important to Montana. The primary purpose of EPSCoR is to serve as a change agent and catalyst to develop a base of research competitive scientists and programs. The development of this strong research base will in turn improve the quality of education we provide to our citizens at all levels, and lead to spin-off developments in other areas of technology and economic development.

EPSCoR is contributing to competitive science, job creation and quality education

EPSCoR is facilitating the growth of competitive science and the improvement of the quality of education. The quality of an undergraduate education is critically dependent on the quality of the faculty and equipment and the opportunity to become engaged in creative activities in partnership with faculty members and graduate students.

- At Montana State University (MSU), grant and contract expenditures have gone from $9.7 million in 1980 to over $35 million this year. Of this, over $5 million is direct support (stipends and tuition) for students; over $22 million is for salaries -- making research at MSU one of the top ten employers in the state.

  So, in rural states like Montana, research itself can be viewed as an important "industry" and "employer" in addition to the benefits which it brings to scientific development and education.

- EPSCoR has also contributed to the enhancement of K-12 education in Montana. Most of those who teach our K-12 students are educated in the state universities. Many of the teachers who receive in-service training do so as a result of linkages and collaborations which grew out of EPSCoR and other NSF systemic reform efforts. Additionally, we have worked with our tribal colleges to develop both curriculum materials and the telecommunications infrastructure to deliver them.

- In states like Montana with little industrial research base and few large private-sector research capabilities, universities have a special role to play. In these states, if there is to be "credible" science upon which to base decisions about natural resource use and preservation, agricultural production and marketing, transportation, and a host of,other issues of local importance, then that science is likely to come from the university community. If a state government needs information on demography, rural health services, water quality and many other issues, it looks, to a large extent, to the university community. If a small business or a small manufacturer needs help with technology applications, research and management, it looks to the university community as a resource. NSF EPSCoR has supported and enabled Montana universities to be more effective in these activities across the State and nationally.

- EPSCoR has helped -- and I believe will increasingly continue to help -- form the foundation for business and industrial R&D in Montana. Some 98% of Montana businesses have fewer than 50 employees; 80% have fewer than 10. Nationally, industries spend $5.14 on R&D for every $1.00 spent at universities on R&D. In Montana, it is just the reverse: universities spend $6.40 on R&D to $1.00 by the private sector. Without university-based research support, states like Montana would be left out of the scientific and technology enterprise of this nation.

EPSCOR IS CHANGING FOR THE BETTER THE STATEWIDE ATMOSPHERE FOR SCIENCE AND TECHNOLOGY IN MONTANA

- Businesses and industry in Montana obviously do not have the human or capital resources to do research or to have individuals who are knowledgeable on recent research findings and can effect appropriate technology transfer and application. NSF EPSCoR caused the creation of the Montana Science and Technology Alliance and the development of the State's "Science and Technology Plan" and the "S&T Action Agenda." NSF EPSCoR has also facilitated the development of linkages and partnerships among universities and colleges, the private sector, the state and federal government. Universities have responded to the Action Agenda and created programs which work with industry on research opportunities, which provide technical and business assistance, which transfer technologies and new product lines, and which assist in accessing personnel and facilities.

- However, having said this, I must emphasize that EPSCoR cannot -- and should not -- be viewed as a technology program or an economic development program. Its focus should continue to be more limited to develop university-based research. It is, however, an essential part of the foundation for technology development, application and transfer. And, it will continue to be.

EPSCoR works in Montana

- We in Montana are fortunate to have a number of "great" EPSCoR stories. One is about Jack Horner, who received a $15,000 Montana EPSCoR grant in 1981. Jack Horner's discovery of dinosaurs in Montana has resulted in major new knowledge of these great animals and helped inspire the book and subsequent movie *Jurassic Park*. His work stimulated creative activity in literature and the performing arts. It contributed to economic activity which has grown out of interest in dinosaurs -- books, toys, etc. It helped awaken and challenge the curiosity of children throughout America. It opened the way for new graduate work and, in his case, offered an opportunity to a number of non-traditional graduate students. And, it contributed to a greater understanding of early life on our planet.

- Even more important, Jack Horner is part of a larger research community at MSU. His work and other EPSCoR research not only contribute to our core efforts but also inspire and promote broader activity. Good things often do cluster, and I think we have seen some of that even though our research activities themselves at MSU are diverse, as well they should and need to be.

- EPSCoR also helped us develop the base for an NSF-supported Engineering Research Center.

We support an expanded EPSCoR for the future

I believe EPSCoR is working in Montana. A relatively small amount of federal funding is having a disproportionate impact on research, education, the science base and technology development and deployment in the State. It is creating critical linkages and partnerships among universities, the private sector and State and Federal governments. It is a sound investment in the future of Montana and therefore the nation. However, it is only a start and the state still has a long way to go. The changes are in the right direction, and EPSCoR has helped insure that.

Montana strongly supports the outlines of an expanded EPSCoR detailed earlier by Dr. Danek.

Senator BURNS. Dr. Saunby, we can hear from you now.

STATEMENT OF DR. JOHN B. SAUNBY, MEMBER, EPSCoR ADVISORY BOARD AND PAST CHAIRMAN, WEST VIRGINIA EPSCoR

Dr. SAUNBY. Good morning, Chairman Burns, Senator Rockefeller. It is an honor to appear before you this morning, particularly to talk about something that is near and dear to my heart.

I was involved with EPSCoR and have been since the early days, since 1980, both as a committee member and chair of the West Virginia EPSCoR Advisory Board.

Senator BURNS. Could you pull your microphone a little bit closer to you, please? There you go.

Dr. SAUNBY. And during that time, I was also the Director of Research and Development for Union Carbide in West Virginia. I was never sure which job was more onerous, but one of them paid me and the other did not.

West Virginia was one of the original EPSCoR states, and during that initial period, we funded individual investigators. Of the individual investigators that we supported, 75 percent of them became nationally competitive.

And that was the name of the game in the initial EPSCoR program.

However, there was a problem. While we were able to increase the capability of the researchers to be nationally competitive, they became more attractive to the other states, too. So we did lose people who we supported during that first phase.

We were fortunate to enter the second phase of EPSCoR in 1990, and the difference we made then was that rather than fund individual investigators, we funded research clusters.

This to us was a much better approach as the life of a cluster obviously exceeds the life of any of the incumbents, and it is not as vulnerable if one of the investigators is attracted away.

We funded three centers. The first one is Non-linear Dynamics. I was going to talk about chaos theory, but I thought being in Washington, that may not be appropriate. [Laughter.]

Dr. SAUNBY. This is the study of non-steady-state phenomenon and has particular value to the chemical industry.

And in West Virginia, it was also of interest in the study of gypsy moth migration.

So it is a very broad technology. But the interesting thing about the Non-linear Dynamic center is that it is headed up very well by one of the graduates of the first EPSCoR program, Professor Ken Showalter. And he has been a real star in our firmament.

The reputation of Dr. Showalter and the center is international. In fact, their work appeared on the cover of "Nature" last year. They also had articles in the "Science," so they are very well known, very well respected and a very productive center.

The Center on Computational Materials looks at mathematical modeling to predict the performance of high temperature alloys. The EPSCoR role was both in stimulating and helping to equip that center using some massive parallel computing capability.

This center has a very good industrial advisory board and in fact has interacted with INCO Alloys in the development of high temperature alloys for turbine blade applications.

The third Center in Cell Regulatory Biology is at Marshall University, and this center came into being as a result of EPSCoR. The initial proposals we liked. They had to fund, staff, equip, and a very effective center in the molecular biology area has come into being.

The thrust of their studies is hypertension and identification of the causative factors that lead to hypertension.

They have come up with some neat chemistry that has identified the peptides responsible and are working with a pharmaceutical company to look at opportunities for commercialization of what has come out of this program.

The EPSCoR program has been an integrating force for science and technology in West Virginia. And we have been able to bring in people from the two- and 4-year colleges to participate in some of the EPSCoR programs.

We only have two research universities, and if we have a quick look at the map of the states here, you will see that we are able to spring our wings geographically.

The green diamonds are some of the two- and 4-year colleges that we were able to support in a program in which we gave instrumentation grants for small research programs.

These grants of $5,000, $10,000 allow them to buy specialized equipment for a specified research project.

And the excitement caused by this program for a minimum cost has been great, and the knowledge of EPSCoR, the knowledge of research, has paid off very well by this geographic distribution of funds.

The advisory boards that we have used, both for the main program and also for the individual cluster programs, have been broadly based.

We have members from not only industry but also from state government and the universities. So we try to bring in the practicality of the work by having broad-based advisory boards.

Now, the benefits of EPSCoR in West Virginia.

Undoubtedly the quantity and quality of research in the state has improved as a result of EPSCoR. We have moved from a low base, but it really has seen a significant shift.

We have the improved ability to attract and retain outstanding scientists. We had a critical need for a material scientist in the computational materials area, and we were able to attract Dr. Chang, an outstanding man in his field. There is no question we could not have attracted him had we not had the Computational Materials Center.

We have also been able to undertake this difficult step and try to get this balance between basic, applied and industry research by the criteria that we set for the programs that are submitted for EPSCoR support.

The first requirement is still the same one that you heard from Dr. Lane, and that is the projects must pass merit review. If they are not good science, we are not interested.

But as we supporting them also out of state funding, we want them to have state relevance.

Sometimes it is a bit tenuous, but usually, a lot of them come in with a very clear opportunity for state relevance directed at economic development, because that is really the name of the game.

We have seen increased interaction between the universities. Marshall and West Virginia University talk to each other. We have seen increased interaction with industry, with the 4-year colleges through their advisory boards.

And like you heard from Montana, the research funding coming in that has been generated as a result of EPSCoR has increased significantly.

The Cell Regulatory Biology program is just about ready to be weaned from EPSCoR. They are ready to migrate, and they already have $2 million of non–EPSCoR funding available. That was a very important part of our view of EPSCoR.

One of the questions we ask these clusters is: How do you plan for life after EPSCoR, because EPSCoR is an initiation grant? It is a bridging grant.

And so we do not expect this to be a life-long source of funding for any of these centers. If they are good enough, they ought to be able to get their own funding.

But therein lies part of the difficulty. We need the stability from the EPSCoR program, because when we are talking dollars, we are talking people. And we must ensure that we have the long-term or intermediate term stability so we can make that transition from EPSCoR to non–EPSCoR funding.

The program we feel is very successful. We appreciate the support from the National Science Foundation and hope that we can see continued support in 1996.

Thank you.

Senator BURNS. Thank you, Dr. Saunby.

[The prepared statement of Dr. Saunby follows:]

Testimony of
Dr. John B. Saunby

before the
Subcommittee on Science, Technology and Space
Senate Commerce, Science and Transportation Committee

The Honorable Conrad Burns
Chairman

March 30, 1995

Good Morning, Chairman Burns and distinguished members of the Subcommittee. It is an honor to appear before you this morning. I am John Saunby, a member of the EPSCoR Advisory Board and past Chairman of the West Virginia EPSCoR Program.

West Virginia (WV) was one of the states selected in the initial EPSCoR program in 1979. A requirement of EPSCoR was that the state assess its research capabilities and needs and design a plan to strengthen its capabilities. This was the first systematic study of this type conducted in West Virginia, and was beneficial in identifying potential areas of research strength. In this first EPSCoR program, the stated objective was to bring individual researchers to a nationally competitive level. I am pleased to say that of the 39 investigators originally funded, 26 became nationally competitive, and over 50 percent remained in West Virginia.

When EPSCoR was reauthorized in 1986, greater emphasis was placed on developing research clusters rather than individual investigators. We felt this was a much better approach as a cluster has more stability and is not vulnerable to the loss of a single individual. In Phase I, the risk was that having achieved a nationally competitive level, a researcher would be seduced by a more affluent state.

In reviewing proposals for clusters in WV, a basic requirement was that the technical quality be such that they would meet merit-review standards. As matching funds were being provided by the state, the next most important requirements was that they have state relevance, preferably related to long-term job creation.

Three areas were selected for development as follows:

> *Non-Linear Dynamics*, with the objective of establishing an interdisciplinary research center of excellence. This Center has established an international reputation with a substantial record of presentations and publications with topics related to the chemical industry, and the dynamics of gypsy moth population growth.

Computational Materials, with the objective to design and improve the efficiency of the development of materials for specific industrial applications. Advanced computer techniques have enabled molecular dynamics to be applied to the design of alloys of industrial importance. Specifically, high-temperature structural alloys have been modeled to aid in the design of alloys with improved fracture and oxidation resistance.

Cell Regulatory Biology, to establish a nationally competitive group to study the mechanisms governing contractions and cell growth in smooth muscle. Staffing and equipping this new group at Marshall University was made possible through EPSCoR funds. Studies of hypertension have identified the role played by a peptide component, especially those having a sequence of five to eight units. Determination of the structure of a second hypertensive factor and a projected synthesis methodology led to discussions with a pharmaceutical manufacturer for its use commercially in diagnostic or therapeutic inventions. This Center, having been created and weaned with EPSCoR funds, is now ready to graduate with non-EPSCoR funding of over $2 million in research grants being awarded to its members.

EPSCoR has been an integrating force for science and technology in WV. Students at the WV Institute of Technology are involved in the Computational Materials program and the Center has an active advisory board with broad industrial representation. The Non-Linear Dynamic group has members from the Chemistry, Physics, Mathematics, and Chemical Engineering Departments at West Virginia University (WVU) and its summer intern program had ten participants including some students and faculty from smaller community colleges. The Cell Regulatory Biology Program has brought the Medical Schools at Marshall University and WVU closer together and its advisory board has representation from WVU and the pharmaceutical industry. An instrumentation program in which small grants are given to two- or four-year colleges has been especially well-received and the projects facilitated by these grants enthusiastically presented at the annual state EPSCoR conference.

To understand the technology needs of the state, the EPSCoR Advisory Board has members from industry and state government as well as from the major research universities and four-year colleges. As the number of Federal agencies funding research through the EPSCoR model has increased (DoE, DoD, NIH, NASA), the need for a state science and technology strategic plan has become more pressing to ensure that the main technology needs of the state are addressed and overlap avoided. The EPSCoR Advisory Board has been addressing this issue and has carried out a planning study which was recently discussed with Governor Caperton. He instructed WV EPSCoR to move forward with development of a proposal for a WV Science and Technology Strategic Plan and Council in order to implement the plan. The mission of the Council is:

> "To strengthen the state's science and technology infrastructure, including research and development and fully integrate it into the state's industrial and economic development strategies."

The expected outcomes of a successfully implemented state S&T strategic plan include the following:

- Technically proficient new entrants into the labor market.
- Upgraded skills in the current work force.
- Research and development in universities relevant to state needs.
- Increased and more relevant R&D funded by industry and Federal agencies.
- Increased deployment and more effective utilization of technology.
- Integration of science and technology into state policy.

I am pleased that the following benefits have been accrued to WV through participation in EPSCoR:

- Improved ability to attract and retain outstanding scientists.
- Better university research targeted toward needs.
- Broadened knowledge of, and interest in, science.
- Increased interaction between the universities and colleges.
- Increased interaction between universities, industry and state government.
- Increased research funding.

West Virginia EPSCoR is proud of the achievements we have accomplished thus far. However, several issues must be addressed for us to continue developing a strong science and technology infrastructure. These include:

- The stability of EPSCoR programs, and the ability to transition investigators and groups into the mainstream Federal and private sector research programs in the EPSCoR funding time-frame.
- Matching funds, especially as the non-research component of the program increases.
- Support for basic versus applied research.
- Industrial linkages.

On behalf of the West Virginia EPSCoR Advisory Committee, I want to thank you for this opportunity to testify. EPSCoR is a relevant, cost-effective successful partnership which serves as a model for the Nation. In order to expand EPSCoR, and take this initiative to the next logical step, West Virginia EPSCoR offers the following recommendations for the future:

- Continue the EPSCoR programs with increased emphasis on centers for advanced technology.
- Increase the size and duration of grants, subject to acceptable performance against milestones.

Senator BURNS. I have a hard and fast commitment at 12 noon today, and I just want to ask a question of Dr. Danek and one of— Dr. Swenson, I am going to turn you over to Dr. Rockefeller. We have too many doctors around here, too many titles here. I cannot handle all this. [Laughter.]

Senator BURNS. And then I will try to get through my obligation and try to make it back. If you are still going, well, I have some other questions to ask.

Dr. Danek, I noticed on your—on the little handout that you gave us, on the back, you had zeroed USDA and—in your EPSCoR funds.

Dr. DANEK. Right. I need to note for the record that I have not zeroed them out, but that is what is being requested by the Administration in FY 1996 for those programs.

Senator BURNS. Well, then, I will ask the head, the guy of the Administration, right?

Dr. DANEK. Yes, sir. [Laughter.]

Dr. DANEK. The question—the real question that is raised, which is the most important issue, is the stability of the EPSCoR program from year to year across the Federal Government.

In FY 1995, there was $81 million available within the program. The request for FY 1996 is $45 million, which, as I said, was one-half of 1 percent of the total Federal R&D dollars awarded to universities and colleges.

An equally important question is how do we balance the support for existing quality centers of excellence and the development of new science and technology centers across the country.

And one must ask an investment of one-half of 1 percent of Federal R&D funds in EPSCoR sufficient for developing the states that were shown on the map?

And I might note, sir, that six out of the nine subcommittee members come from EPSCoR states, and a majority of the full committee members come from EPSCoR states.

Senator BURNS. Well, thank you very much. I am going to—I will be back, and I want to ask a couple questions of you. I am going to turn this over to Senator Rockefeller, and I will get back here as soon as I possibly can. But I cannot budge that—I can fight everybody in the world, but you cannot fight that clock.

If you wrap it up, well, you wrap it up, and we will have some questions for you. OK? You might ask Bob Swenson for some examples of how it has helped Montana State University, give us a couple of examples of that.

Senator ROCKEFELLER [PRESIDING]. Dr. Swenson, can you give me some examples of how this has helped Montana? [Laughter.]

Dr. SWENSON. Well, with the important man leaving the room, I have to tell him, I guess, off the record, will I not? [Laughter.]

Dr. SWENSON. I think there are lots of ways it has helped us. Probably the most important way, Senator Rockefeller, is it has created a different environment, both on the campus and within the community, as well as state-wide.

It has brought to the fore the importance of education and the importance in particular of science and technology education in the state, and the importance of that for future jobs and for the future

economic well-being of the state. I think that is the most important thing it has done in general.

It certainly has allowed us to develop a rather large number of competitive scientists now, and it has allowed us to bring together from a variety of campuses in the State of Montana groups with similar interests and allowed them to begin to develop collaborative research programs.

And finally, and what is most important to our state legislators is that these groups that are forming from across the state are beginning to do research together with, in partnership with, the private sector.

And we have a number of examples where private sector partners with the university have led to specific product lines that those companies have been able to sell.

I think that, in a nutshell, is the importance of EPSCoR programs.

Senator ROCKEFELLER. I think that is very important to say.

And, Dr. Saunby, I want to obviously come to you, because you spent many years in West Virginia helping on this. I think that in what tend to be more rural states, where universities do not think of themselves as Harvards or MITs or Stanfords or Johns Hopkins but have within their capacity to attract people who have the capacity to be much more advanced, if they feel that there is something out there supporting them.

And I think as is so often true in rural states, it is psychology that is at work, and something like EPSCoR is tremendously important. I remember Erich Bloch, whom I enormously admire.

He just really was intrigued by EPSCoR. And he and I and a number of others had some real discussions on this, and the program did pick up once again.

But I really believe in the atmosphere aspect, that there is a collaboration, that it is OK to be aggressive about science.

I remember in West Virginia—and, Dr. Saunby, you can comment on this—I think there was a period of time when it was tough to get our legislature to go along with EPSCoR, tough to get our Governor to go along with that.

But then as things develop, you attract your Dr. Changs, you attract other possibilities, people's confidence picks up, and it gets to where it ought to be in the first place.

And actually, I would love—you gave a number of examples of how it did help West Virginia—but I would love you to give a few more, if you could, because I really believe in this program.

I think it is the same theory as most good ideas. They do not come out of IBM and do not come out of Motorola. They come out of the small and medium-sized businesses.

And there is no reason there should be any difference between that example and this example in terms of science and ideas.

Dr. SAUNBY. I think as we look at our programs, the one thing that happened was the coalescence of different departments within West Virginia University. You know, that may sound trivial, but it really is not.

To break down the barriers between physics, chemistry, mathematics, electrical engineering and have them come together to form

the Non-linear Dynamic Center, they came together to develop a proposal, even before they had funding.

It was exciting that these people realized that the coalescence was what was important.

We have had in West Virginia a strong industrial leadership on the advisory board. The current chairman is Dr. deBarbadillo from INCO.

So our focus has been a little different, because while we support and understand the need for basic research, we also look at the need for research to lead somewhere.

And this is where many of our discussions, as we have talked and, as you mentioned, with Governor Caperton have led. We are still getting to understand the timeframe for EPSCoR versus the timeframe for industrial research, the need to establish centers and the need to establish to credibility, the need to develop basic chemistry, basic science which precedes application.

And just one comment: We met with Governor Caperton, and we talked about the program when we were asking for funding for phase two. He was supportive of the concept.

And then he turned to us and said, "How many jobs will this create in West Virginia?"

So we are trying to bridge the mindset between jobs today, instant gratification and a research program which promises jobs in the future. We did get support. He did support us. And our position, quite frankly, was this is the precursor of job opportunities. It does not lead to jobs today.

So we have been able to really structure programs that have state relevance and that is understood by the people in the House and the Senate of West Virginia.

So that is the approach we have taken, to say not instant gratification, but we are talking futures. You must invest in the future if you are to have ultimate success for the state.

Dr. DANEK. Might I add something to that, Senator, in terms of the future?

Senator ROCKEFELLER. Please.

Dr. DANEK. All of the EPSCoR states and all of us here support the position of increased funding for the National Science Foundation for all of the mainstream programs. It is the goal of EPSCoR to increase the number of individuals, in the states that we represent, in the mainstream programs of NSF.

This is one of the reasons the EPSCoR Foundation was created. And I am pleased to note that Mr. Erich Bloch has agreed to be the Chair of the National Advisory Board for the EPSCoR Foundation. The Foundation plans to look at some of the issues that are being addressed today, and some of the issues that will face the Nation and EPSCoR in the future so that the EPSCoR program can be as successful as it has been in the past.

Senator ROCKEFELLER. I am going to close the panel now, primarily because I think there is tremendous support, not just from the Chairman but myself and others on this committee, tremendous support for EPSCoR. There is not a sense of trying to probe for weaknesses. It is a question of just outright support on the committee.

And actually, it raises an interesting thing, going back to my original point. Government money can be used to stimulate something as critical, for example, as bringing different faculty members from different departments together at West Virginia University. I agree with you, that is an enormously important happenstance, because there may be three or four key people in each of the departments, or even one or two key people.

And bringing them together through the lure of something from the outside or the discipline from something outside and opportunity, you just help the bureaucracy and the culture of university do something that often does not happen on its own.

EPSCoR has been able to do that. I can remember going to an exhibition of science and technology put on by West Virginia University, and EPSCoR had its own booth, so to speak, and they were just ravenous trying to get me to come over there and spend time.

There was a bunch of it. And that is the point. I mean, that is the point, that minds, ideas, cross-fertilize at West Virginia University or Marshall University, or at Montana State University.

Those things become tremendously important. And there are not other mechanisms in place that would otherwise cause that to happen.

But it interests me, also, that again this is government money, and universities are not an industry. This is not industrial policy, but this is, however, a specific commitment on the part of government to use government to engender something which would otherwise probably not happen in rural states. It is a valuable use to me of public funds, because it causes excellent things to go on.

So I will not probe further. I have some other questions here, but they are such softballs that I am really embarrassed to ask them, because they are just to elicit statements of support for you. And I think we are all in agreement on this.

So I hope that EPSCoR will continue to be very much in the minds of our people. I have been approached both by people who teach at West Virginia University and at Marshall, very enthusiastically about this, are extremely excited about it.

And it is a sense of maybe West Virginia can move from here to here. And just the idea of moving from here to here becomes very exciting. It stimulates collegial possibilities and work. It has great meaning.

And I am sure those things have meaning at Stanford and Harvard and other places, too, but they just are needed very much at a broader array of universities and colleges.

So I want to thank all of you. You came considerable distances, some of you, and I think that definitely needs to be noted.

You were listened to by two Senators, not by an entire committee. Do not be shocked by that. That happens quite a bit, because we all belong to a variety of committees.

But I think the support for EPSCoR is very strong. Your testimony is most affirming and therefore very helpful. And I thank all of you a lot.

[Whereupon, at 12:06 p.m., the hearing was adjourned.]

APPENDIX

Prepared Statement of Dr. Pamela A. Ferguson, President of Grinnell College

I am pleased to offer testimony for this Committee, and bring attention to issues relating to the reauthorization of the National Science Foundation and the NSF FY 1996 Budget Request. I will do this from the perspective of the independent, predominantly undergraduate institution—from Grinnell College and other colleges within the Associated Colleges of the Midwest, and from the Central Pennsylvania Consortium, and other member institutions of the Independent Colleges Office.[1]

I have two points to make:

I. That discussions about reauthorization of and budget for the National Science Foundation must be based on a clear understanding of how a strong undergraduate community serves the national interest. A vital science and mathematics community at the undergraduate level is central to the ability of NSF to achieve the first goal stated in the recently-announced NSF Strategic Plan:

[The goal to enable] the U.S. to uphold a position of world leadership in all aspects of science, mathematics and engineering [is based on] the conviction that a position of world leadership in science, mathematics and engineering provides the Nation with the broadest range of options in determining the course of our economic future and our national security (NSF95–24[NEW])

II. That NSF and the nation's colleges and universities have a shared responsibility to build and sustain undergraduate programs in science, mathematics, engineering, and technology education that serve the national interest; that collectively we must strive to achieve the further goals presented in the NSF Strategic Plan:

[The goal to] promote the discovery, integration, dissemination, and employment of new knowledge in service to society... [The goal to] achieve excellence in U.S. science and mathematics, engineering and technology education at all levels. This goal is worthy in its own right, and also recognizes that the first two goals can be met only by providing educational excellence. It requires attention to needs at every level of schooling and access to science, mathematics, engineering and technology educational opportunities for every member of society. (NSF95-24[NEW])

The institutions I represent request that:

- This Committee take aggressive action to ensure NSF's ability to serve the national interest, particularly maintaining a vital program of science education at all levels.

This is the 50th Anniversary Year of the founding of NSF, as well as of the end of the Second World War and the dropping of the atomic bomb. NSF was established "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." In the Authorizing Act, NSF was directed to:

initiate and support basic scientific research and programs to strengthen scientific research potential and science education programs at all levels in the...sciences [and] engineering.. (National Science Foundation Act of 1950)

Such a mission is no less critical today than at the outset of the Cold War, or in the days after Sputnik. I join many others in celebrating the contribution of the National Science Foundation, and anticipating its continued contribution, specifically my role is to bring your attention to the value of NSF programs that have an impact at the undergraduate level. The current generation of undergraduates—the 12 million students now studying for associate and baccalaureate degrees on over 3,000 campuses across the country—will be responsible for the quality of life and the economic vitality of our nation in the first decades of the 21st Century.

As Director Lane said recently,

Producing faculty is not the only goal; we need to prepare more young people in science for a wider range of careers. Many professions are going to require a founda-

---

[1] ICO members include: Allegheny College (PA); Augsburg College (MN); Beloit College (WI); Carleton College (MN); Coe College (IA); Colby College (MA); College of the Holy Cross (MA); College of St. Catherine (MN); The Colorado College (CO); Cornell College (IA); Dickinson College (PA); Franklin and Marshall College (PA); Furman University (SC); Gettysburg College (PA); Grinnell College (IA); Hope College (MI);Kalamazoo College (MI); Knox College (IL); Lake Forest College (IL); Lawrence University (WI); Macalester College (MN); Manchester College (IN); Monmouth College (IL); Oberlin College (OH); Ohio Wesleyan University (OH); Pomona College (CA); Reed College (OR); Ripen College (WI); Scripps College (CA); St. Olaf College (MN); University of Redlands (CA); University of Richmond (VA); Wheaton College (MA).

tion in science and technology to be part of the future of this nation. (Science, November 4, 1994)

Increasingly also, as science and technology have an impact on all life, we all need to know more and better science to ensure that students, indeed all of us, are prepared to be productive citizens.

Lewis Thomas said it very well:

We need to know more. We cannot stop where we are, stuck with today's level of understanding nor can we go back I do not see that we have a real choice in this, for I can see only the one way ahead We need science, more and better science, not for its technology, not for leisure, not even for health or longevity but for the hope of wisdom which our kind of culture must acquire for its survival

*****

In Attachment I is presented some pertinent data about ICO institutions, with comparative data from a select group of universities and colleges. Please note the measurable productivity of this group of institutions; we are in the sector of higher education that has 3% of the undergraduate enrollments and produces about 16% of the Ph.D.'s. We are also leaders in the current effort to transform undergraduate science/math education. Attachment II includes excerpts from the article in the November 4, 1994 *Science* which focused on innovations in classroom and lab, highlighting many of the programs on the campuses which I represent.

*****

I. A strong undergraduate community serves the national goals of competitiveness and leadership.

The question often asked is:

• Is the balance between research and education activities at NSF is correct, as reflected in the FY96 Budget request?

The term "balance" is not one I prefer to use, since it suggests some quantifiable measure, or a sense of competition. I propose that the question be:

• Is research and education are becoming integrated in a manner that truly serves the national interest?

and that we then ask:

• What does integrating research and education mean for the capacity of undergraduate SMET programs to contribute to national competitiveness?

The undergraduate sector is the critical link in the national effort to build a productive workforce. Here we prepare the K-12 teachers and the next generation of science professionals, those who will be leaders in corporations and governments, persons who will need a clear understanding of the nature of science and the potential (and limitations) of technology. For most of those who will be the next generation of leaders—among whom will be current students at colleges and universities across the country—the undergraduate years will be their last formal opportunity for a rigorous intellectual engagement with science and mathematics, engineering and technology.

Colleges like Grinnell, and my ICO colleagues, operate under an implicit contract with our students, with the families of our students, and with the citizens of this nation to provide an education that sends out graduates equipped to lead productive and self-fulfilled lives. When the faculty, administrators, and Trustees at Grinnell reflect on that contract, we know we have to sustain strong programs in science and mathematics if our students are to be well-prepared for their world. Indeed, we know we have to continue to do even better if we are to attract the kind of students who aspire to be leaders into the 21st Century.

As a community we look at how we educate all our students, those with interest in K-12 teaching, those (a growing number) who come to us with a clear sense that a career in one of the scientific or technological fields is right for them, and those students who look toward careers in fields outside of science and technology. We look at what works in getting students interested and involved in the study of science and mathematics. Here is what we found:

• hands-on experiences for students, in beginning courses through senior projects;

• interdisciplinary, collaborative teams of students and students, students and faculty, faculty and faculty;

• networking computers for use by majors and non-majors—interfacing computers and lab equipment;

easy access for all students to the most sophisticated equipment;

courses that connect to the real-life experience of students;

• persistent personal contact between faculty and students—in class and, especially, in the lab;

• space and time for the serendipitous encounter that is an essential part of doing science; and

• facilities that are safe, and that accommodate such an environment for learning.

We found what works is when research and teaching are integrated, when senior professors and newly-appointed faculty are committed to translating their research into learning experiences for students—all students, majors and non-majors, those who aspire to be K-12 teachers and those working toward a career in industry or academe. This has been the culture for many years on our campus, and this is the key reason for the productivity of Grinnell and other ICO institutions.

Why is this important? Why is integrating education and research, providing hands-on learning opportunities for students—at all levels and with different career aspirations—in the national interest?

The answer is clear: we need a workforce for the future with the kind of skills learned through a rigorous encounter with science and mathematics; we need a citizenry prepared to make decisions about issues with scientific and technological dimension. The corporate leaders with whom I speak regularly describe the kind of people they seek to hire: persons who can ask questions, solve problems, and work collaboratively, persons who know how to communicate the results of their work, persons who know how to use computers and other sophisticated equipment.

Such skills are developed when students have the opportunity to "do science" as scientists do science. More and more, what is happening on campuses across the country is that students are being taught how to ask questions, question evidence, and use computers and other sophisticated instrumentation in seeking answers. Many of the innovative courses now being developed for beginning students provide "research-training" opportunities. These courses challenge them to take an active (rather than passive) role in shaping their understanding and to work collaboratively in teams—sharing ideas freely and taking collective responsibility for the results of their work. Many of these students, particularly those who become majors, are actively involved with faculty research projects.

If you were to visit one of our campuses during the academic year or summer, you might see students and faculty working together on NSF-funded projects exploring:

• the interaction of the solar wind with the Earth's near-space environment (even traveling to the Arctic Circle to install instrumentation);

• the impact of the zebra mussel on indigenous mussels in the St. Croix River; or

• the relationship between parasite infestation and cancer incidence in mammalian hosts.

Given in Attachment II are fuller descriptions of these and other current research activities on ICO campuses, activities through which students gain a sense of the wonder and excitement of doing science, and are impelled to continue their learning. Research and education are integrated on our campuses. For us, involving undergraduates in research and research-training is just another way of teaching. Our collective responsibility is to provide such opportunities, at least in a limited way, to all undergraduates.

Increasingly, NSF policies and programs are integrating education and research in creative ways. The new CAREER program, which supports young faculty with demonstrated ability to integrate teaching and research, is one critical pilot program (succeeding a similar program focused primarily on advancing the research careers of young faculty). Another is the new Collaborative Research in Undergraduate Institutions (CRUI) program, which recognizes that the boundaries between the disciplines are dissolving. CRUI supports multidisciplinary research projects that involves undergraduate faculty and students. Each of these new programs should be evaluated; they should be expanded. (CRUI received about 330 applications, and will be making only 20 awards. Demand outstrips supply!) Through programs like these, NSF sends signals to the community that faculty who spend time with students, integrating research and educational activities, will be rewarded at the national level.

Support for such activities fits precisely into the NSF mandate, to invest in research and education in all aspects of science, mathematics, and engineering. Research done with undergraduates, although it may not be done at the speed as when post-docs and Ph.D.'s are solely involved, does advance the discovery and integration of knowledge. Thus, when it is done right—when research and education are truly integrated—you get "two for the price of one" creating new knowledge and giving students the skills to succeed in life. Is not this just the kind of effectiveness and efficiency we are all seeking to achieve?

II. NSF and the nation's colleges and universities have a shared responsibility to build and sustain undergraduate programs in science and mathematics that serve the national interest.

Grinnell and my sister institutions could not have done what has been completed so far, and will not be able to finish what is planned, without many partners—

friends of the college (individuals and private foundations); without the financing opportunities provided by state and local governments; and without the important leveraging support from the National Science Foundation. NSF grants to the undergraduate community set the standards for our work in research, research-training, and education; they provide further incentive to colleges like mine by helping to set the parameters for effective planning for curriculum and facilities renewal; they leverage critical dollars from other donors, and they enable us to make a significant contribution to the community.

A question was asked at a Hearing of the House Subcommittee on Basic Research:

• Are NSF's programs duplicated within the Federal government?

This is a critical question, at a time when every budget line item is being examined (on campuses as well as in Congress). I will answer it from the perspective of the undergraduate community. Attachment IV gives data from the 1992 FCCSET study, which identifies NSF as the nearly sole source of support for undergraduate programs. If we are to build and sustain the strong undergraduate SMET community this nation needs, NSF is the key to making this happen. It is important to note here that, even given the significant increase in funding for education at NSF over the recent past, funding levels for undergraduate programs has been relatively flat.

NSF support for instrumentation, for course and curriculum development, for facilities, for partnerships and for faculty development is critical to the capacity of undergraduate institutions to continue to serve the national interest. This is a public policy issue, and should be considered just as carefully as issues about the balance between curiosity-driven and strategic research. Budget justifications within the Research Directorates in the NSF FY 1996 Request describe how the Foundation is the nation's principal supporter of fundamental academic research. This is the same case we must make for the undergraduate sector.

At this point I would like to address the question:

• What level of funding should be provided to the academic research facilities modernization program?

My answer will be: the level of funding in the original authorization of the Academic Research Infrastructure (ARI) Program—$250 million.

The physical environment for research and research-training on our campuses is in a crisis situation, a crisis at three levels. First, many buildings are deteriorating, structurally inflexible, and obsolete. Many need to be brought up to standards for health and safety. Many need to be renovated to accommodate computer networks and other sophisticated technologies that are now an integral part of the undergraduate experience. Second, the generation of facilities now in use were designed for passive learning, for spoon-feeding bits of information into students, for a learning environment where the faculty member was "in control." I described earlier what works. To have programs that work requires spaces that accommodate the active, collaborative, community-based approach to learning. The final dimension of the crisis is the present fiscal climate. To do SMET education right is costly; it will be more costly for the nation over the long-term if we do not do it right.

It is important not to lose sight of the fact that we are not asking NSF or the federal government to meet all our needs, not even most of them; we are asking for a partnership that works together to find new ways of financing infrastructure needs, working together on a national agenda.

There are significant strengths of the current ARI program, as authorized, that I must emphasize:

• As mandated by Congress, it provides support in an equitable fashion to institutions large and small, public and private, in all parts of the country.

• It sets national standards for planning, helping to ensure that the current generation of facilities will serve the community well into the next century.

• It is a grassroots program, in that institutions identify their own priorities.

• It is a merit-review process, not a pork-barrel program. The best projects get funded.

Although not explicit in the authorization language, one valuable dimension of the program has been that it exists at all. Planning new spaces (new construction or remodeling projects) takes about three-five years. In my case at Grinnell, beginning in 1991 through the projects currently underway, we will have committed $14.5 million to modernizing facilities for science and mathematics programs. Bringing together the resources to make this happen was a difficult task; the NSF grant we got early on was a significant catalyst, leveraging the further support needed to complete the project. I have reviewed the ARI awards lists since the program began; many members of this Committee have institutions in your district that have applied for and received ARI grants. To be successful, they, like Grinnell, had to develop a comprehensive scheme for planning and fund-raising that incorporated the

possibility of NSF ARI finding. We could manage our affairs more effectively because of the partnership with NSF.

One of the persisting questions Congress is asking NSF officials is:

• How do we know your program's work?

There is clear evidence on undergraduate campuses across the country that undergraduate programs work:

• in getting students interested in science and math by giving them the right tools for learning,

• supporting faculty research that involves students as partners, and

• in educating the next generation of K-12 teachers.

These programs, I will emphasize again, are not duplicated in any other agency—federal or state. They are a significant investment in the economic future of this country.

Thus, my final recommendation:

As this Committee and your Congressional colleagues wrestle with where to get the best return-short-term and long-term an investment in infrastructure for the future of this country, supporting education, research-training, and research at the undergraduate level will be your best bet.

As this Committee considers issues about the mission, aims and objectives for NSF into the 21st Century, we urge you to keep in mind that a strong National Science Foundation is absolutely central to our nation's continued economic success, and to our continued capacity to enable all citizens to achieve their greatest potential-through education and through work, and through the discovery, integration, dissemination, and employment of new knowledge in service to society.

[NOTE: ALL ATTACHMENTS LISTED BELOW ARE MAINTAINED IN SUBCOMMITTEE FILES]

ATTACHMENT I.

• UNDERGRADUATE ORIGINS OF EARNED PH.D.'S

• SCIENCE AND BACCALAUREATE DEGREES AS PERCENTAGE OF UNDERGRADUATE ENROLLMENTS

ATTACHMENT II.

• EXCERPTS FROM SCIENCE,

Innovations on Campus. Volume 266, 4 November 1994

Descriptions of programs on ICO campuses:

1. Page 250. Some Small Schools are Big on Manufacturing Scientists.
(St. Olaf College, Grinnell College, Reed College, Carleton College, Pomona College, and Oberlin College)
2. Page 856. Assault on the Lesson Plan.
(Reed College and Dickinson College)
3. Page 858. Curricula Reform Hits the Web.
(Gettysburg College)
4. Page 875. New Modes for Making Scientists.
(Dickinson College, College of the Holy Cross, Oberlin College)
5. John Jungck: Godfather of the Virtual Bio and Genetics Labs
(Beloit College)

ATTACHMENT III.

• DESCRIPTION OF SELECTED RESEARCH/EDUCATION ACTIVITY-ICO CAMPUSES

ATTACHMENT IV.

• FCCSET STUDY OF FEDERAL SUPPORT FOR UNDERGRADUATE SMET PROGRAMS

ATTACHMENT V.

• EXCERPTS FROM FOUNDATIONS FOR THE FUTURE, NSF Publication

QUESTIONS ASKED BY SENATOR PRESSLER AND SENATOR BURNS AND ANSWERS THERETO BY JOHN H. GIBBONS, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

SENATOR PRESSLER QUESTIONS

General

QUESTION: 1. How would you describe the Administration's overall approach to science and technology policy and what are that policy's goals and priorities?

As enunciated by the President in his first month in office, our science and technology policies and programs are directed toward three basic goals:

• strengthening the economy through private investment in research and development and the growth of innovation-based enterprises;

• reforming and streamlining government, to make it work better and cost less, with a fair, efficient, and effective regulatory system that encourages rather than discourages innovation;

• world leadership in science, mathematics and engineering.

Federal investments in S&T are a key element of a comprehensive strategy to prepare for the 21st century.

Government is an essential actor in making sure science and technology help us reach our goals. Many of the benefits science and technology confer are in areas that are either outside the market or imperfectly subject to market forces—such things as a strong national defense, first-class education and training, improved environmental quality, and fundamental scientific research. In these areas, a strong government presence in R&D investments is essential.

A government role is also vital in promoting technologies that are critical to economic growth, the creation of good jobs, and meeting the common needs of the nation, but cannot attract adequate private investment. In our partnerships with business for pre-commercial technology development, our cardinal rule is to use government funds only where they are essential and where the payoff to society as a whole is large. We invest government funds, on a cost-shared basis, where private sector investment is not adequate to the job because of unacceptably high technical risks, prohibitive cost, long payback horizons, or where the returns cannot be captured by the investing firm but spill out to competitors, other firms, or society at large.

At the beginning of this Administration, President Clinton committed to an integration of agency R&D budgets to ensure the Nation's S&T investments served broad national goals as well as agency missions. This Administration recognizes the contributions that R&D can make to the vitality of this country as we move closer to the 21st century. R&D guidance—in the form of broad policy principles and goals—has been issued to guide the individual agencies' budget development. The guidance reflects a significant paradigm shift in the way the Federal R&D enterprise is addressed, both from a budget and a policy standpoint.

The R&D policy principles direct the agencies to:

• emphasize peer review
• invest in human resources
• invest in fundamental science
• integrate civilian and military research programs wherever possible
• integrate environmental objectives into other goals
• encourage cost-shared research partnerships with industry and with States
• invest in anticipatory R&D
• promote international cooperation
• promote equity and diversity

The President's budget is the single most important statement that reflects his commitment to S&T for economic growth. The budget reflects the Administration's policies and priorities as follows:

(1) Within a tight S&T budget, we made room for a 3.5 percent increase in basic research. Basis research is a crucial investment for our future economic well being and for providing the quality of life that Americans rightfully expect, providing the highest rate of return of any federal investment. This growth has not been easy to achieve. One third of the nation's basic research budget is in mission agencies—DOE, DOD, NASA—that are under especially heavy fiscal pressure.

• Support for academic research is maintained. Investments at universities yield a particularly high return, in part because the investment adds both to the knowledge base and to training the next generation of scientists and engineers.

• This activity will rely on peer and merit review even more than in the past to make sure that our scarce research dollars are spent on the best research by the best scientists, for the greatest return on the American taxpayers' investment.

(2) The budget is focused on harnessing S&T to solve real problems and create real opportunities for all Americans. As exciting or as important as it may be, it's not enough to say we're close to finding missing matter in the universe, or that we're gaining a better understanding of the nature of carbon sinks in the tropical rain forests. To the majority of Americans, these aren't the central issues. That is why the President's budget also is focused on providing what the public expects in addition to new knowledge from their investments in science and technology, things such as:

- Continued economic growth and job creation;
- National security, both in defense and competitiveness;
- Education and training for ourselves and for our children in the new technologies that hold the key to our economic future;
- Better health, safe food and water, and a healthy environment.

(3) The FY96 budget requests increased funding for technology partnerships with U.S. Industry. These partnership programs represent a small but increasingly vital component of the federal R&D portfolio.

- Funding is increased to support work with industry on high-risk civilian industrial technologies of critical importance to the country.

(4) Information technology is a priority in the FY96 budget. New information technologies are transforming the way Americans communicate with each other, the way businesses operate, the way we learn and the way we use our leisure time. These are key investments for a nation whose future is tightly linked to the success of information technology.

- Increased funding is requested for the High Performance Computing and Communications program for advanced research in technologies critical to development of the information superhighway.
- We will pursue a focused initiative to develop Technologies for Education and Training. Information technology is helping businesses become more productive and better able to serve the needs of individual customers. But this revolution largely has bypassed the nation's schools. The goal of this initiative is to create new tools to revolutionize learning in the information age for students and workers of all ages.

(5) Improved understanding of the environment will contribute to a healthier, safer America and a stronger economy:

- $5.5 billion in funding for environment and natural resources research is proposed in FY96, a 4% increase over FY95.

(6) The FY96 budget strengthens the federal investment in health, and in agriculture and food research that will lead to new ways to prevent and treat disease. This investment will also enhance agricultural productivity and sustainability, food safety, and environmental quality:

- Funding at the National Institutes of Health increases 4% ($468 million). Highest priority is given to investigator-initiated research grants related to targeted areas such as the health of women and minorities, disease prevention, and DNA sequencing technologies.
- Agriculture research emphasizes food safety, human nutrition, germplasm preservation and genome mapping, reduced dependence on chemical pesticides, water quality, and sustainable agriculture.

(7) With a NASA budget of $14.2 billion, the Clinton Administration is seeking to maintains America's leadership in space exploration, science, aeronautics, and technology. We have entered a new era in space, one with new research priorities and new emphasis on efficiency and working in partnership with private industry.

The international space station has been redesigned to reduce its cost, to improve its performance and safety, and to accelerate its schedule. The inclusion of Russia as a full partner in the station program meets important programmatic and foreign policy goals.

(8) Continued science and technology investments are critical to our national security. Superior technology allows us to field the strongest military at the lowest cost—both economic and human.

- This budget shows our firm commitment to defense basic science—the seed corn on which our technology programs depend.
- We are giving priority to: programs that improve our warfighting capabilities, such as information technology and advanced modeling and simulation that are changing the battlefield, giving individual soldiers, sailors, and airmen the benefit of our global information leadership; programs that address affordability, such as manufacturing and production technologies; and technologies for new missions, such as counter-proliferation, that are growing in importance.
- Many of the technologies we need for advanced military capabilities are available in the commercial sector, and in some cases they are more advanced and cost less. Through increased funding for partnerships with industry, we are breaking

down the barriers between the defense and commercial industrial sectors so that we have access to the best of both for our military applications.

• We can use American leadership in international science and technology cooperation to address global issues such as proliferation of weapons of mass destruction, excessive population pressure, food scarcity, environmental degradation, deteriorating health conditions. These conditions are incompatible with the promotion of stability, economic growth, and the spread of democracy.

QUESTION: 2. What is the overall federal R&D budget and how is that budget divided between civilian and military activities? Is it still the Administration's goal to strive for a 50-50 split between civilian and military R&D?

The President's FY 1996 budget proposes $73 billion of spending for R&D. Under this budget the civilian share of R&D should be approximately 51 percent by 1996 if the estimates account for so-called "dual-use" defense R&D, and 48 percent if they do not. The Administration is still committed to a 50-50 split between civilian and military R&D.

Technology Policy

QUESTION: 3. In Congress, we have had an ongoing debate about the appropriate role of government in boosting U.S. competitiveness. Some prefer technology grant programs like the Commerce Department's Advanced Technology Program and the Defense Department's Technology Reinvestment Project. Others believe in a less intrusive role for the government which stresses tax cuts, enforcement of existing trade agreements, tort reform, and deregulation.

QUESTION: 3. a) Where do you stand in this "industrial policy" debate?

QUESTION: 3. b) Do you believe that technology grant programs pick "winners and losers" or merely lend high-tech firms a helping hand?

The term "industrial policy" has no consistent definition and we have not used the term in formulating research policy.

ATP and TRP are not "grant programs." They are industry-led, cost-shared partnerships to pursue projects that are competitively selected based strictly on merit.

The Administration has stated repeatedly that technology is the engine of economic growth. The productivity gains possible only through innovations are the primary basis for gains in national income, job creation, national security, and the quality of American life. The key to ensuring that America benefits from the promise of new technology is to ensure that American businesses have the incentives they need to conduct research and invest in the innovations that result. We have strongly supported reforms that minimize the burdens of regulation and ensure an investment climate favorable to innovation. Indeed, well crafted regulations, developed with the assistance of the businesses regulated, can spur innovations that contribute both to business success and improvements in the environment. The Administration has also strongly supports tax credits for research and engineering within budgetary constraints.

Even with all of these programs in place, however, a number of research areas critical to the nation's future will not be supported by private investors. Unremitting competitive pressures have forced many US firms to reduce spending for projects they know are essential for their long-term profitability. There are many areas where research critical to the nation's economic future, or critical to a public objective like environmental quality or education, cannot be supported entirely by private firms because the benefits of the research are shared widely, and cannot be captured primarily by the company funding the investment.

Federal applied research programs are designed to provide funding only when there is convincing evidence that private firms can not, by themselves, undertake the technical or financial risks involved. We have worked closely with industry to develop criteria for selecting appropriate areas for federal funding and require significant cost-sharing to ensure that participating firms are serious in their commitments. Some concepts prevail in this process and others do not.

In short, we believe that a balanced program is needed with federal research funding providing a small, but critical part of the portfolio.

QUESTION: 4. The FY95 Budgets of both the Advanced Technology Program and the Technology Investment Program [Technology Reinvestment Project] were cut in the recent rescission bill. To what do you attribute the Congressional opposition to these programs?

This nation has a history of investing in applied research that dates back to the Morrill Act of 1862, which established the land grant colleges. The nation has been a world leader in areas such as aviation, aerospace, agriculture, and transportation due to partnerships with industry; these partnerships have met national security, technological and economic goals. Technology partnerships such as the Advanced Technology Program and the Technology Reinvestment Project are programs that follow in the historical path of such efforts.

However, with the end of the Cold War, there is a new debate regarding the proper role of government. This debate is heightened due to severe pressure to reduce the budget deficit. It is apparent, however, that technology partnerships have been brought into an ideological debate.

This Administration has strongly supported industry-led partnerships with the recognition that given global competition, government and industry must work together to advance technology and to realize economic benefits for the nation. This Administration will continue to invest in such partnerships to ensure a growing economy, high quality jobs and technological advances.

Coordination of Multiagency Federal Science Programs

QUESTION: 5. Your office has the responsibility for coordinating the Nation's interagency federal science programs, many of which have annual budgets exceeding $1 billion.

QUESTION: 5. a) What are the major interagency science programs supported in the current federal budget and what are their funding levels?

QUESTION: 5. b) What, if any, changes in these programs are made in the FY96 budget request?

The following are selected, major interagency science and technology programs supported in the current budget:

	FY1995 estimate	FY1996 proposed	Dollar change 95–96	Percent change 95–96
	($ millions)			
Technology Learning Challenge	328	335	+8	+2%
Partnership for a New Generation of Vehicles	246	333	+87	+35%
Construction & Building	141	169	+28	+20
Physical Infrastructure for Transportation	247	321	+74	+30%
Environment & Natural Resources *	5,339	5,536	+197	+4%
U.S. Global Change Research Program *	2,118	2,157	+39	+2%
High Performance Computing and Communications	1,080	1,142	+63	+6%

* U.S. Global Change Research Program is a subset of the Environment and Natural Resource initiative.

NSTC Technology Learning Challenge (TLC): The TLC is a partnership with industrial, educational, and training institutions using computers, new communication systems, and other advanced technologies to improve the quality, accessibility, and productivity of learning experiences for all Americans. The budget proposes four major focus areas (innovative technologies and demonstration projects, learning tools, evaluation techniques, and cognitive process research). For 1996, nine agencies are proposing $335 million for this effort. An Interagency Technology Office, established within the Department of Education, will carry out the initiative.

Partnership for a New Generation of Vehicles (PNGV): The PNGV or "Clean Car" initiative is a partnership with U.S. industry to ensure the global competitiveness of the U.S. automobile industry and its suppliers and improve environmental quality. It is structured around two near-term goals—better manufacturing technologies and better emissions control of conventional engines—and a major long-term goal—developing an attractive, affordable car with three times the fuel efficiency of today's vehicles.

The budget proposes investments in 14 technologies, targeting most Government funding to the third, long-term goal. Eight agencies participate in the initiative: the Departments of Commerce, Defense, Energy, Interior and Transportation, and EPA, NASA, and NSF. Their combined budget proposal is $333 million in 1996, an increase of $87 million or 35 percent above 1995.

NSTC Construction and Building (C&B): A partnership with U.S. industry, C&B is designed to improve the productivity and safety of building construction practices and the affordability, quality, and environmental characteristics of buildings. C&B has set goals and priorities in three broad areas: technology improvements, such as information and decision technologies; non-technical barriers to improvements, such as regulatory barriers; and the deployment of technology, including training and demonstration projects. Seven agencies are proposing $169 million in 1996, an increase of $28 million (20 percent) over the 1995 level.

NSTC Physical Infrastructure for Transportation: This partnership with industry is designed to improve the quality and lower the cost of building and maintaining highways, bridges, ports, rail lines, airports, and other parts of the Nation's physical

transportation infrastructure. The budget provides funds to expand programs associated primarily with accelerating R&D on new materials and with the methods of assessing infrastructure conditions. For 1996, five agencies are proposing $321 million, an increase of $74 million, or 30 percent, over the 1995 level. R&D activities include airport security and pavement technology, and research and technology in highway materials, pavements, and structures.

NSTC Environment and Natural Resources (ENR): The ENR initiative focuses on R&D programs associated with global change, biodiversity and ecosystems, air quality, natural resources and management, water resources, coastal and marine resources, toxic substances, hazardous and solid wastes, and natural disaster reduction. Twelve agencies propose $5.5 billion in 1996, an increase of $197 million or four percent over 1995. The total for ENR includes $2.2 billion for the U.S. Global Change Research Program (USGCRP).

NSTC High Performance Computing and Communications (HPCC): The HPCC program involves nine agencies and is designed to ensure U.S. leadership in information and communications technologies and help lay the technological foundation for the National Information Infrastructure initiative. It supports research on computer science and engineering, and the development of applications of information technology in commerce, manufacturing, education, public safety, health care, and other fields. The budget proposes $1.1 billion for HPCC in 1996, an increase of $63 million or six percent over 1995.

QUESTION: 5. c) How does your office coordinate the activities within each interagency program and what role does the National Science and Technology Council play in that coordination process?

In order to confront the budgetary, scientific, and technological challenges of the 21st century, the Administration recognized that significant changes were needed in the way we plan and fund Federal R&D. The traditional single-agency, single-discipline approach to problem solving must be supplanted by a coordinated, multi-agency, interdisciplinary approach. Multi-dimensional problems can only be addressed by bringing together natural and social scientists, economists, engineers, and policymakers. For too long, science has been decoupled from informing policy decisions. Fixing this disconnect has been one of our highest priorities.

Over the past two years, the Administration has been working to improve the Federal R&D enterprise in many ways. For the first time, the United States has a comprehensive, coordinated Cabinet-level body devoted to coordinating the Federal R&D enterprise. In November 1993, the President created the National Science and Technology Council (NSTC). The principal purpose of the NSTC is to:

- identify national goals that require concerted R&D efforts;
- identify the high-priority R&D needed to meet those goals; and
- coordinate R&D government wide to make sure that adequate attention is given to high-priority areas, and to avoid wasteful duplication

Although each agency, to accomplish its missions, must have R&D directed to its particular needs, there are some commonalities in the science and technology needs of all the agencies. Put another way, overarching national goals typically cross agency boundaries. This is particularly true because of the highly interactive nature of research and development with its many feedback mechanisms. The NSTC provides a structure in which to prioritize the many legitimate demands on the public's R&D dollar. It assures a forum where critical national needs cannot be pushed aside by urgent and parochial agency needs. It can sensitize agencies to the advantage of symbiosis over isolated pursuit of objectives.

Through its nine standing committees, the NSTC has identified R&D priorities that link our S&T activities to critical national goals. The nine NSTC standing committees are organized in the following principal areas: fundamental science; health, safety, and food; environment and natural resources; information and communications; national security; civilian industrial technology; transportation; education and training; and international science, engineering and technology.

Unprecedented cooperation among the member agencies in 1994 enabled these committees systematically to prepare research and development strategies to meet the goals. OSTP worked with the Office of Management and Budget to ensure the priority areas received adequate attention—all within a level R&D budget. The result is a coherent, efficient R&D agenda.

To meet the Nation's goals in the years ahead—and to continue meeting them as the goals evolve—requires that we set priorities for R&D now, with a farsighted vision for the future because most of the S&T enterprise is inherently a multi-decade process. Even within the science community, it can take decades to recognize the significance of a scientific discovery. The NSTC provides the mechanism for providing the vision and deriving priorities. By creating a "virtual" S&T organization, the NSTC enables the Administration to maintain a productive research and develop-

ment activity in each S&T-dependent agency while simultaneously achieving the efficiencies of a cross-linked system.

QUESTION: 5. d) How does your office guard against duplicative activities within each interagency program and what procedures does your office use to evaluate whether a program is meeting its goals and missions?

Encouraging interagency coordination among the member agencies of national research programs is one of the principal goals of the Committees of the National Science and Technology Council (NSTC). The objective is to look at the entire federal S&T enterprise to maximize the federal government investment in S&T and to ensure that the resources are being applied to reach national goals. The Committees of the NSTC are responsible for the planning, development, and review of programs across agencies focused on common goals. They produce strategic plans that set forth each program's major scientific and technological objectives. They also develop implementation plans that set forth the contributions (milestones, deliverables) of each of the participating agencies' individual research programs and projects. Development of these strategies and implementation plans enables agency program managers to identify both programmatic overlaps (which would lead to duplication) and gaps (which could lead to the inability to meet scientific program objectives), and to effectively redirect resources to address research needs.

Some programs, such as the U.S. Global Change Research Program, have established a working group structure and a small coordinating office to facilitate interagency coordination. They also seek to establish effective coordination with related national and international scientific activities at universities and industry laboratories, for example, as well as to make sure that the research programs are addressing issues of concern to various stakeholder groups such as industry, non-governmental organizations, state and local governments, and the Congress.

Specific activities of the Committees include: (1) initiating scientific planning efforts as required; (2) tracking program progress, identifying problems or gaps and recommending solutions; (3) developing, reviewing and disseminating information products that describe program goals and accomplishments; (4) complying with any statutory requirements, such as the development and routine revision of a ten-year research plan; and (5) ensuring consistent, interagency compliance with Executive Branch directives and requirements such as the annual OMB budget crosscut and regular reports to NSTC and OSTP.

FY1996 R&D budget guidelines established by the Directors of the Office of Science and Technology Policy and the Office of Management and Budget in May of 1994 included broad policy principle, goals, priorities and evaluation criteria. The R&D evaluation criteria were established to evaluate the appropriateness of interagency NSTC programs identified by agencies. These criteria include: technical/scientific merit, relevance/contribution, knowledge diffusion, readiness, timeliness, linkages, costs, and agency approval.

Privatization

QUESTION: 6. Across the federal government, Congress is seeking to identify programs that might be more cost-effectively performed by the private sector. In some areas, the private sector may be able to provide better service at less cost to the taxpayer.

QUESTION: 6. a) What are your views on proposals to privatize certain government activities like the Space Shuttle and other federal R&D programs?

Not enough information is presently available to fully assess privatization of the Shuttle program. However, as restructuring options are formulated and assessed, the possibility of privatization is being considered. Among these is an option to transition Shuttle operations to a single prime contractor. The options focus on reviewing the Program requirements and management structure in light of the increasing maturity of Shuttle operations and the fact that most of the hardware upgrades development will be completed by fiscal year 1998. Options include elements of civil servant down-sizing, safety and mission assurance reallocation, transition of operational responsibilities to contractors and consolidation of activities with the Space Station Program. The transition timing from today's program structure to a new structure will be key to its success. A working group has been formed to review and integrate the findings and recommendations of all the reviews and studies associated with restructuring the Space Shuttle Program. The results of this effort are expected in the late-May time frame.

QUESTION: 6. b) Is the Administration considering any government-wide study of which federal R&D programs might be privatized?

The Administration is looking at this question in all areas, including R&D, as part of the National Performance Review - Phase II. In a memorandum to federal

agencies in January, 1995, the Vice President asked for examination of the basic missions of government, looking at every single government program and agency to find and eliminate things that don't need to be done by the federal government. The Vice President asked the agencies to examine if the agency were eliminated, how would the goals or programs be undertaken—by other agencies, by states or localities, by the private sector, or not at all?

Space Station/Space

QUESTION: 7. a) What is the current status of this (Russian and European funding commitment) situation?

As a result of the Space Station Redesign effort and the decision to invite Russia to join the program in 1993, as well as shrinking space budgets in Europe, European participants asked ESA to reassess its contribution to the program. This reassessment was conducted throughout 1994, and during its March 22-24, 1995, Council meeting, ESA could not reach firm agreement on funding for its anticipated contribution to the international Space Station program. This contribution consists of the Columbus Orbital Facility (COF), a pressurized laboratory, and the Ariane-5/Automated Transfer Vehicle (ATV), a vehicle for the transport of pressurized and unpressurized logistics.

In anticipation of the March ESA Council meeting, the White House and the Congress engaged their respective counterparts regarding European participation in the program. Each reaffirmed the United States' support for the international Space Station, and conveyed the importance of a continued European role in the program through the provision of the COF, as the highest priority European contribution, and the Ariane-5/ATV.

The present uncertainty surrounding the European commitment to the program involves the extent to which individual European participants will financially support the ESA package. The big four member states of ESA (Germany, France, Italy, and Belgium) have separately conveyed, at executive and agency levels, their support for a continued European role in the program; however, they face budget environments similar to that of the United States. In addition, the interplay of nine difference budget cycles adds an additional challenge, as budget decisions are on different timetables for each country.

For this reason, ESA did not secure complete financial and legal endorsement of its Space Station elements at the March Council. However, the United States is hopeful that ESA will achieve European consensus on its Space Station contribution later this year. The financial and legal endorsement is expected to follow in October at the ESA Ministerial-level meeting.

Recent French presidential elections brought in a new administration which may require transition time. The French government has said it should have a position developed by autumn, which seems a reasonable schedule from their point of view. France and the European partners have individually signalled their continued desire to participate in the Space Station program, but the financial level of each country's commitment has yet to be finalized. NASA is working closely with ESA in its effort to obtain the necessary member nation consensus in that regard.

NASA is also confident its Russian partner will live up to its commitments on the program. This confidence is based on Russia's known technical capabilities, on significant progress in developing effective working relationships, and on demonstrated successes in our joint activities to date.

Since October 1992, when NASA and the Russian Space Agency (RSA) signed the first agreement on human space flight, expectations have been backed up by real achievements. In this short time, two Russian cosmonauts have flown on board the U.S. Space Shuttle, and NASA astronauts have been in training in Russia for over a year. Most recently, Astronaut Norm Thagard became the first American to fly on board a Russian spacecraft, and at this moment he is carrying out duties as a crew member on the Mir space station.

Russia is also living up to its commitments on the international Space Station. Nearly 85 per cent of the design drawings for the Functional Cargo Block, the first element of the station to be launched into orbit, are already complete. Coordination between NASA, RSA, and Russian subcontractors has grown steadily, with frequent meetings and teleconferences between managers and technical experts at the working level, as well as regular reviews for senior management.

Russia is clearly going through a difficult period as it continues to move toward a market economy and to develop and strengthen democratic institutions. The Russian government, including President Yeltsin and Premier Chernomyrdin, has demonstrated strong support for the space program. We see no indications that this support is lessening.

QUESTION: 7. b) What are the consequences for Space Station in the event of either the Russians or the Europeans pulling out of the program?

The likelihood of either the Russians or Europeans withdrawing from the Space Station program is small. Nevertheless, neither Russia nor ESA is on the critical path to Station mission success. In the case of the Europeans, the United States would lose some research capability in the event of their withdrawal. The agreement with ESA allocates nearly 50 percent of the European lab research capability to the United States. While elimination of European participation would require reconfiguration of Space Station elements and assembly sequences, it would not preclude the United States from going forward with the program.

A two-tier strategy has been developed to deal with the issue of Russian withdrawal from the program. The first instance deals with a situation in which Russia withdraws formal government participation, but Russian contractors are still available to NASA as contractors. The second scenario assumes complete inaccessibility to Russian resources, in which case NASA would be required to find alternate contractors for the Russian-provided hardware. Among these, the most critical would be the Functional Cargo Block. Although this element is well within the technical capability of the U.S. aerospace industry, it would be a long-lead-time procurement.

QUESTION: 7. c) Do you believe the Russian involvement in Space Station produces net benefits for the program and the Nation?

Russian participation is a thoroughly positive element of the Space Station program which produces significant benefits for the program and the Nation. Their partnership saves the U.S. some $2 billion in assembly costs; produces a Station that has more volume, a larger crew, more power, and comes on line earlier than the previous design; and takes advantage of the Russian knowledge base of years of operations experience. Moreover, this concept helps promote the democratization of Russia, stimulates its market economy, and facilitates Russia's entry into the world's family of free nations.

QUESTION: 8. One of the primary reasons the U.S. agreed to Russian participation in the Space Station program was to discourage the sale of sensitive technologies to unfriendly nations. However, we understand the Russians are seeking to sell nuclear technology to Iran. How would you respond to this?

Space station cooperation is a major element in encouraging Russia's cooperative engagement with the world's family of free nations. We have undertaken that cooperation because it is in our mutual interest. Also, Russia has made important commitments related to avoiding proliferation of missile capabilities. Russia's discussion with Iran regarding the transfer of nuclear power-generating reactors is a matter of great concern to us, but it is a separate matter. We have made our concerns clear to Russia, including at the May Summit. The Russians have agreed to continue discussing the potential proliferation implications of such supply, and we hope to persuade Russia that the sale should not go forward.

QUESTION: 9. NASA's Mission to Planet Earth and the multiagency global change research program are aimed at providing the answers to difficult environmental problems. After the global change satellites are launched, what information will they provide and how will that information benefit the average taxpayer?

The goal of the U.S. Global Change Research Program (GCRP), which includes NASA's Mission to Planet Earth (MTPE), is to provide the scientific and technical information that will allow us to protect the environment and human health, while realizing economic growth, job creation, and enhanced national security. The knowledge generated from these programs will be used to assess the impact of human activities on the environment; the consequences for human health, ecological systems, and socio-economic sectors including agriculture, forestry, fisheries, and water resources; and the effectiveness of various adaptation and mitigation strategies. These programs will provide governments and the private sector the scientific basis required for informed, equitable and cost-effective national and international policy formulation on a variety of issues including climate change, ozone depletion and land-use. For example, farmers, foresters, water and natural resource managers, and state and local governments will be able to use this information to devise strategies that will allow them to become more resilient to natural climate variability (e.g., floods, droughts, and heat waves) and extreme events (hurricanes, tornadoes and cyclones), and will allow them to devise strategies for mitigating or adapting to human-induced changes in climate.

NASA is already gathering significant amounts of data from Upper Atmosphere Research Satellite (UARS), Ocean Topography Experiment (TOPEX)/Poseidon, Laser Geodynamics Satellite (LAGEOS), Total Ozone Mapping Spectrometer (TOMS)/Meteor-3, and Earth Radiation Budget Satellite (ERBS) about the Earth's upper atmosphere, atmospheric ozone, oceans, radiation budget, and crustal dynamics. Over the next three years, a variety of additional satellites will be launched by NASA and

its partner agencies in MTPE that will provide additional data about ocean circulation, ocean productivity, weather, atmospheric ozone, lightning, and tropical rainfall patterns. Beginning in 1998, the Earth Observing System (EOS) satellites will provide long-term measurements on an unprecedented number of Earth system parameters. Data from these satellites are used in conjunction with data from in situ measurement sites and field campaigns by scientists supported by NASA and other GCRP agencies. The research effort is aimed at developing an understanding of the causes and mechanisms of change through studies of Earth system processes, developing a predictive capability through modelling and analysis of the components of the Earth system and their interactions, determining the consequences of change, and assessing the effectiveness of mitigation and adaptation options.

In addition to the basic science and research conducted within MTPE and the GCRP, several programs are under way to bring the benefits of research and use of NASA's satellite data to the state and local level. MTPE is developing an infrastructure through the Earth Observing System Data and Information System (EOSDIS) to make Earth science information more accessible to the public. For instance, the Earth Resources Observation System (EROS) Data Center in Sioux Falls, SD provides users with land processes imagery that has the potential to be translated into valuable applications. We are encouraging private industry and state/local governments to transform this basic Earth science information available from EROS and other NASA Distributed Active Archive Centers (DAACs) into value added products that meet the needs of their defined user community. In the Plains states, such as the Dakotas, this data will be especially useful for farmers and ranchers. This undertaking by NASA and other federal agencies in the GCRP is part of an overall effort to examine the best way to establish government, academic, and commercial partnerships to extend the utilization of global change data to non-research user communities such as education, agriculture, state and local planning, adjudication, transportation, and emergency management.

QUESTION: 9. a) What are some of the applications of the data which would be relevant to the agricultural community?

One example of this is a project to utilize space-based remote sensing to provide information to the agricultural community on the extent and status of specific crops and thus enable them to estimate aquifer use rates. Additionally, the MTPE and GCRP climate modeling and prediction research will lead to greater accuracy in long-term weather forecasting, which will be of great benefit to the agriculture community. We have developed the ability to monitor and forecast El Nino events and their consequences. We expect that these forecasts will become a routine operational product that supports effective decisionmaking in crop selection, planting and harvesting, and investment decisions in the agricultural sector, as well as helping to mitigate the effects of extreme weather events such as droughts and floods. In fact, research data are already being put to practical use; NASA has established it's first cooperative arrangement with a local TV weather station to use NASA's data available over the Internet as part of their daily broadcasts.

QUESTION: 10. South Dakota is very proud that, for the last 20 years, the EROS data center in Sioux Falls has archived Earth imagery from the nation's Landsat satellites. What do you see as the future of the Landsat program, and what role will Landsat play in the growing commercial remote sensing market?

Landsat has been and will continue to be a critical part of the nation's remote sensing satellite program. Landsat data provides invaluable information for national security and the scientific community, e.g., for understanding global climate change, while also producing a wealth of data for farmers, foresters, land use and resource planners, and local and state governments. The Administration is committed to continuing Landsat-type measurements.

NASA is developing the Landsat 7 satellite, planned for launch in 1998. Per direction from President Clinton, Landsat 7 spacecraft development responsibility transitioned from DoD to NASA in the spring of 1994. NASA is leading the development of the ground system, which is funded jointly by NASA and NOAA. NOAA will be responsible for Landsat 7 operations and USGS will be responsible for data archival and distribution. Together, these agencies comprise Landsat Program Management (LPM). A joint Management Plan for the Landsat Program was signed in August, 1994, and the Data Policy Plan was signed in mid-April, 1995, by all three LPM agencies. Current plans call for unenhanced data from Landsat 7 to be priced in accordance with OMB Circular A-130, i.e., at the cost of filling the user request.

Landsat makes an important contribution to the promotion of the growing commercial market for remote sensing data. The provision of Landsat system unenhanced data at the cost of fulfilling user requests meets public-benefit research needs, and at the same time removes a "high cost of market entry" barrier for new commercial firms. This opens the door for "value-added" firms to process the data

to produce images with substantial commercial value. The "business end" of the remote sensing industry is in the tailoring of imagery products to the needs of a wide variety of users in the agricultural, resource management, urban planning, and other industries.

To prepare for the future, one of the decisions made in NASA's 1994 rebaselining of the Earth Observing System (EOS) program was that Landsat measurements will be incorporated into EOS. A Landsat Advanced Technology Instrument (LATI) is tentatively scheduled to fly as part of the second flight of the EOS-AM series of measurements (planned for launch in 2004). This instrument will incorporate improvements in remote sensing technology while maintaining continuity with data from earlier Landsat missions. The synergy of making measurements at the same time as other EOS-AM instruments will only make the Landsat-type data more valuable.

A number of exciting and innovative efforts are underway that will influence the design and capability of land remote sensing systems for both government and industry. The work at NASA on the Lewis and Clark missions—which both feature small, cutting-edge, high resolution imaging instruments—will help advance the state of imaging technology and bolster private sector capability in this field.

Such improvements—as well as those possible through NASA's proposed New Millennium program—will not only contribute to the planning for LATI, they will also stimulate the growing applications industry for Landsat and other remote sensing data.

National Labs

QUESTION: 11. The federal budget supports a system of 700 national laboratories, many of which are pursuing outdated Cold War missions.

QUESTION: 11. a) What can we do to make these labs more relevant to U.S. competitiveness and other national strategic needs?

The three largest Federal laboratory systems, those of the Department of Defense, the Department of Energy, and the National Aeronautics and Space Administration, account for at least three-quarters of what the Federal Government spends in its laboratories. These three systems were each reviewed individually over the past year or two, and they are the subject of an interagency review by the National Science and Technology Council that is virtually complete but not yet published. The individual reviews concluded that each agency's laboratory systems are able to meet important national needs of the post-Cold War era. The DOD labs are aimed primarily at meeting national security needs. DOE labs have important missions in basic and applied energy research, national security, environmental science and technology, and fundamental science. NASA Centers meet national needs in aerospace, science, engineering, and technology, and astronomy, astrophysics, and earth sciences.

For example, NASA's four aeronautical Research Centers conduct research and technology activities to address key national requirements related to aviation safety, environmental compatibility, and air transportation infrastructure capacity and productivity. In addition, these Centers conduct longer-term, higher-risk research in basic aeronautical technologies to help keep the United States competitive in aeronautics and aviation. NASA's Research Centers also provide critical research infrastructure—wind tunnels, computers and simulators, research aircraft, and propulsion test facilities—to a range of government, industry, and university users. All of these activities are conducted in close cooperation with NASA's government, industry and academic customers and partners to ensure that highest-priority requirements are being addressed in the most cost-effective manner.

These laboratories also have some very important special capabilities in fundamental science. The DOE labs possess large facilities—mostly too large for universities or industry—that support basic research in physics, chemistry, materials science, and certain areas of biology and earth science. NASA conducts some research in astronomy, astrophysics, and the Earth environmental system, that depend entirely on NASA facilities, such as the Hubble Space Telescope. Most of DOD's support for science goes to universities, but some research that is especially relevant to defense, or requires large facilities, is done in DOD labs. All three agencies support university science, though DOE spends a larger proportion of its science funding in house than the others do. In a time of tighter budgets, all three may need to guard against a natural institutional tendency to preserve science activities in house.

QUESTION: 11. b) Do you agree with the recommendation of the recent "Galvin" report that the labs need to be dramatically restructured along the lines of a corporation?

We agree with the conclusion of the Galvin Task Force that governance by the Department of Energy of its major laboratories is broken and must be repaired. The government-owned, contractor-operated system that once offered flexibility and freedom from red tape has become so burdened with orders, directives, audits and reviews that the labs' scientific work is suffering severely.

We agree with the diagnosis. While the prescription—to "corporatize" the labs—has an immediate appeal, it also raises significant concerns. It would seem to require that Congress cede a substantial measure of authority over federal R&D spending and a loss of accountability for public funds.

Another approach—one that the Galvin Task Force recommended as an alternative—is aggressive action by DOE to put its house in order. And in fact, DOE is drastically reducing and simplifying orders and directives to its laboratories, and limiting its own reviews and audits of the labs. DOE is also reinventing itself as an agency, removing layers of management and improving efficiency.

In addition, a new Laboratory Operations Board, composed of senior department officials and distinguished private sector advisors, will provide high-level strategic direction for the labs; develop a mission statement for the lab system and tightly focused missions for each lab; and monitor the department's progress in lifting bureaucratic burdens from the labs. The result should be greater efficiency, less wasteful duplication, and a focus by each lab on work that exploits its best capabilities and contributes to post-Cold War national needs.

Joint Industry-Government Research

QUESTION: 12. One way to cut federal spending is to encourage industry to engage in more joint R&D with the federal government.

QUESTION: 12. a) What are your views about the importance of joint research, particularly research performed under Cooperative Research and Development Agreements?

The accelerating pace of technological advance, ever shorter product cycles, and rapid worldwide diffusion of technologies mean that many companies are finding investment in risky or lower yield research and development less attractive than in the past. This means that government research and development partnerships with industry in growth-enhancing technologies are more important than ever. Without government programs that share the risk at the pre-commercial stage, individual companies are reluctant to take the plunge, especially when a substantial fraction of the total return may not be captured by the individual investing company.

The problem of capturing private returns on pre-commercial research and development investments is especially great in widely dispersed and fragmented industries such as agriculture or building and construction. If government fails to support technology advances in these industries, at least on a cost-shared basis, it will not get done, or it will be done by international competitors.

CRADAs are cost-shared with the private partners and projects are proposed by industry. Unlike other partnership programs, the Federal labs contribute expertise and technology but do not provide funds to the non-Federal party. Rights to intellectual property are negotiated between the laboratory and the participant, and certain sensitive information important to industrial partners is protected from public dissemination for up to five years.

Since the CRADA mechanism was introduced, it has rapidly become the primary mode of industry-driven cooperative technology development with federal labs. Agencies had a combined total of over 5,000 CRADAs, valued at $3.8 billion, at the end of 1994.

QUESTION: 12. b)What is your evaluation of current joint research being done and what are some of the more promising joint research projects underway?

The Advanced Technology Program, or ATP, which is run by the National Institute of Standards and Technology (NIST) in the Department of Commerce, is a flagship technology partnership program. ATP invests in pre-commercial technologies important to national technological goals and economic growth. It is an industry-led, merit-based, and cost-shared program, assuring that projects have real commercial potential. Selection of projects is merit based; it is rigorously competitive—another reason for ATP's fine reputation among business people who know it best. Half of ATP awards go to small businesses, or teams led by small firms. The awards that go to larger firms are usually for new approaches that, however interesting, don't meet corporate management criteria for selection and support, but have the potential for significant and widespread economic benefits down the road.

Government partnership is also critical in developing technologies where the benefits are as much social—for health, education, or the environment—as commercial. The Partnership for a Next Generation of Vehicles (also known as Clean Car) was

designed to tackle an extremely tough technical challenge—to develop within ten years a production prototype car with three times the efficiency of today's automobiles, with no sacrifice in cost, comfort, or safety. The payoff would be enormous and would include lower emissions of greenhouse gases, less dependence on foreign oil, and an extremely attractive car for world markets in the 21st century—a car that is made in the USA by a thriving American auto industry.

The Technology Reinvestment Project (TRP) at the Department of Defense is a dual-use program. Its mission is to exploit commercial technology and commercial markets to meet defense needs. Like ATP, its projects are cost-shared, industry-led, and competitively selected strictly on the basis of merit. But unlike ATP, its primary aim is to meet defense needs through the development of dual-use technologies.

Some TRP projects are designed to propel the commercial development of technologies critical to the military, since low-cost commercial manufacturing practices and economies of scale from large-scale commercial production will make those technologies more affordable to the military. Other projects are intended to spin off defense technologies to commercial applications—and then take advantage of the lower costs and faster pace of commercial production for subsequent purchases by DOD.

This is not just a hypothetical possibility—it is already happening with some military-based technologies. For example, the same MIMIC-based technology that the Air Force uses for its newest phased-array radar for fighter airplanes is the basis for a warning system on school buses. The FOREWARN system has already saved the life of at least one little boy. He was diving for his backpack under the wheels of the school bus, where the driver couldn't see him, when the system's alarm sounded and its display screen showed his location. The FOREWARN system is the product of a joint venture of Delco Electronics and Hughes Aircraft, and it is made on the same production line as the military system on which it was originally based. For the military, the benefit translates to substantially reduced costs, and the prospect for further reductions. On the civilian side, the benefit is access to a life-saving technology for school children and, in the future, safety devices for cars.

One of the great benefits of both ATP and TRP is the teaming they have encouraged, between customer and supplier firms; between private firms, universities and public or non-profit laboratories. In fact, some teams that continued as partners in cooperative R&D despite the fact that they failed to win an award. Writing the proposal opened their eyes to the benefits of cooperation.

QUESTION: 12. c)How can we encourage more private companies to enter into joint research arrangements with the federal government?

One way to encourage more joint research with private companies is to apply our streamlining and reinvention principles to the CRADA process. The number of CRADAs approved has risen steeply since 1993, reflecting our initial efforts to simplify and improve the process by which these agreements are made. In addition to developing model, modular CRADAs with preapproved terms and conditions (easing the burden on researchers and ensuring a certain level of consistency and fairness in the agreements), the Administration's continuing efforts include: making it easier for industry to find the right technical capabilities throughout the federal complex; working with industry sectors to define partnerships that address their most important common problems; developing better metrics to measure the outcomes of CRADAs; and continuing to streamline and ensure consistency in the CRADA process.

SENATOR BURNS QUESTIONS

General Policy

QUESTION: 1. What are the most important science and technology policy issues facing OSTP today and how are you addressing them?

The critical challenge for the federal science and technology enterprise is to reorient it beyond the Cold War, ensuring that federal investments meet national needs. Science and technology are high-leverage investments in America's present and future. This Administration believes that investments in S&T should contribute to a growing economy with more high-skill, high-wage jobs for American workers; a cleaner environment where energy efficiency, information technology, and advanced science and engineering help increase profits and reduce pollution; better access to good health care; a strong national security; greater capability to respond to challenging global problems; a stronger, more competitive private sector able to maintain U.S. leadership in critical world markets; an educational system where every student is challenged to prepare for a new global economy; and an inspired scientific

and technological research community focused on ensuring not only our national security but an improved quality of life for ourselves and our children.

The Office of Science and Technology Policy advances the Administration's goals through the National Science and Technology Council (NSTC). The NSTC is a "virtual" agency, a coalition of agencies that coordinate their efforts, divide tasks, and share resources to advance science and technology. This forum for direct communication between agencies cuts through bureaucracy and led to the identification of common goals and objectives.

Through the nine NSTC committees, natural and social scientists, economists, engineers, and policymakers are brought together to address S&T challenges. The NSTC prepares integrated R&D budgets, policies, and plans in nine principal areas: fundamental science; health, safety, and food; environment and natural resources; information and communications; national security; civilian industrial technology; transportation; education and training; and international science and technology.

QUESTION: 2. What is the role of your office in shaping federal R&D policy relative to other federal R&D agencies like the National Science Foundation?

Agencies such as the National Science Foundation are responsible for developing policies and implementing and managing specific programs within their authority and for providing policy input to the Administration that represents agency expertise and perspective.

The Office of Science and Technology Policy is responsible for interagency coordination of S&T policies and programs and for presenting final advice to the President. Specifically, OSTP:

- Advises the President and others within the Executive Office of the President on the impacts of science and technology on domestic and international affairs;
- Evaluates the scale, quality, and effectiveness of the Federal effort in science and technology;
- Leads an interagency effort to develop and implement sound science and technology policies and budgets;
- Works with the private sector to ensure Federal investments in science and technology that contribute to economic prosperity, environmental quality, and national security;
- Builds strong partnerships among Federal, State, and local governments and the scientific community.

QUESTION: 3. What is the total federal R&D budget request for FY96? How is it divided between civilian and defense research? How does it compare with the FY95 funding for federal R&D? Does the budget request reflect any overriding principles, themes, or policy goals?

The President's FY 1996 budget proposes $73 billion of spending for R&D. Under this budget the civilian share of R&D should be approximately 51 percent by 1996 if the estimates account for so-called "dual-use" defense R&D, and 48 percent if they do not. The proposed budget maintains overall R&D funding at roughly the 1995 level with an increase of 0.2 percent. It proposes about $1 billion more than FY95 for a balanced portfolio of civilian basic research, applied research, and development activities.

As enunciated by the President in his first month in office, our science and technology policies and programs are directed toward three basic goals:

- strengthening the economy through private investment in research and development and the growth of innovation-based enterprises;
- reforming and streamlining government, to make it work better and cost less, with a fair, efficient, and effective regulatory system that encourages rather than discourages innovation;
- world leadership in science, mathematics and engineering.

Federal investments in S&T are a key element of a comprehensive strategy to prepare for the 21st century.

Government is an essential actor in making sure science and technology help us reach our goals. Many of the benefits science and technology confer are in areas that are either outside the market or imperfectly subject to market forces—such things as a strong national defense, first-class education and training, improved environmental quality, and fundamental scientific research. In these areas, a strong government presence in R&D investments is essential.

A government role is also vital in promoting technologies that are critical to economic growth, the creation of good jobs, and meeting the common needs of the nation, but cannot attract adequate private investment. In our partnerships with business for pre-commercial technology development, our cardinal rule is to use government funds only where they are essential and where the payoff to society as a whole is large. We invest government funds, on a cost-shared basis, where private sector investment is not adequate to the job because of unacceptably high technical risks,

prohibitive cost, long payback horizons, or where the returns cannot be captured by the investing firm but spill out to competitors, other firms, or society at large.

At the beginning of this Administration, President Clinton committed to an integration of agency R&D budgets to ensure the Nation's S&T investments served broad national goals as well as agency missions. This Administration recognizes the contributions that R&D can make to the vitality of this country as we move closer to the 21st century. R&D guidance—in the form of broad policy principles and goals—has been issued to guide the individual agencies' budget development. The guidance reflects a significant paradigm shift in the way the Federal R&D enterprise is addressed, both from a budget and a policy standpoint.

The R&D policy principles direct the agencies to:

- emphasize peer review
- invest in human resources
- invest in fundamental science
- integrate civilian and military research programs wherever possible
- integrate environmental objectives into other goals
- encourage cost-shared research partnerships with industry and with States
- invest in anticipatory R&D
- promote international cooperation
- promote equity and diversity

The President's budget is the single most important statement that reflects his commitment to S&T for economic growth. The budget reflects the Administration's policies and priorities as follows:

(1) Within a tight S&T budget, we made room for a 3.5 percent increase in basic research. Basic research is a crucial investment for our future economic well being and for providing the quality of life that Americans rightfully expect, providing the highest rate of return of any federal investment. This growth has not been easy to achieve. One third of the nation's basic research budget is in mission agencies—DOE, DOD, NASA—that are under especially heavy fiscal pressure.

- Support for academic research is maintained. Investments at universities yield a particularly high return, in part because the investment adds both to the knowledge base and to training the next generation of scientists and engineers.
- This activity will rely on peer and merit review even more than in the past to make sure that our scarce research dollars are spent on the best research by the best scientists, for the greatest return on the American taxpayers' investment.

(2) The budget is focused on harnessing S&T to solve real problems and create real opportunities for all Americans. As exciting or as important as it may be, it's not enough to say we're close to finding missing matter in the universe, or that we're gaining a better understanding of the nature of carbon sinks in the tropical rain forests. To the majority of Americans, these aren't the central issues. That is why the President's budget also is focused on providing what the public expects in addition to new knowledge from their investments in science and technology, things such as:

- Continued economic growth and job creation;
- National security, both in defense and competitiveness;
- Education and training for ourselves and for our children in the new technologies that hold the key to our economic future;
- Better health, safe food and water, and a healthy environment.

(3) The FY96 budget requests increased funding for technology partnerships with U.S. Industry. These partnership programs represent a small but increasingly vital component of the federal R&D portfolio.

- Funding is increased to support work with industry on high-risk civilian industrial technologies of critical importance to the country.

(4) Information technology is a priority in the FY96 budget. New information technologies are transforming the way Americans communicate with each other, the way businesses operate, the way we learn and the way we use our leisure time. These are key investments for a nation whose future is tightly linked to the success of information technology.

- Increased funding is requested for the High Performance Computing and Communications program for advanced research in technologies critical to development of the information superhighway.
- We will pursue a focused initiative to develop Technologies for Education and Training. Information technology is helping businesses become more productive and better able to serve the needs of individual customers. But this revolution largely has bypassed the nation's schools. The goal of this initiative is to create new tools to revolutionize learning in the information age for students and workers of all ages.

(5) Improved understanding of the environment will contribute to a healthier, safer America and a stronger economy:

• $5.5 billion in funding for environment and natural resources research is proposed in FY96, a 4% increase over FY95.

(6) The FY96 budget strengthens the federal investment in health, and in agriculture and food research that will lead to new ways to prevent and treat disease. This investment will also enhance agricultural productivity and sustainability, food safety, and environmental quality:

• Funding at the National Institutes of Health increases 4% ($468 million). Highest priority is given to investigator-initiated research grants related to targeted areas such as the health of women and minorities, disease prevention, and DNA sequencing technologies.

• Agriculture research emphasizes food safety, human nutrition, germplasm preservation and genome mapping, reduced dependence on chemical pesticides, water quality, and sustainable agriculture.

(7) With a NASA budget of $14.2 billion, the Clinton Administration is seeking to maintains America's leadership in space exploration, science, aeronautics, and technology. We have entered a new era in space, one with new research priorities and new emphasis on efficiency and working in partnership with private industry.

The international space station has been redesigned to reduce its cost, to improve its performance and safety, and to accelerate its schedule. The inclusion of Russia as a full partner in the station program meets important programmatic and foreign policy goals.

(8) Continued science and technology investments are critical to our national security. Superior technology allows us to field the strongest military at the lowest cost—both economic and human.

• This budget shows our firm commitment to defense basic science—the seed corn on which our technology programs depend.

• We are giving priority to: programs that improve our warfighting capabilities, such as information technology and advanced modeling and simulation that are changing the battlefield, giving individual soldiers, sailors, and airmen the benefit of our global information leadership; programs that address affordability, such as manufacturing and production technologies; and technologies for new missions, such as counter-proliferation, that are growing in importance.

• Many of the technologies we need for advanced military capabilities are available in the commercial sector, and in some cases they are more advanced and cost less. Through increased funding for partnerships with industry, we are breaking down the barriers between the defense and commercial industrial sectors so that we have access to the best of both for our military applications.

• We can use American leadership in international science and technology cooperation to address global issues such as proliferation of weapons of mass destruction, excessive population pressure, food scarcity, environmental degradation, deteriorating health conditions. These conditions are incompatible with the promotion of stability, economic growth, and the spread of democracy.

Relevance of Federal R&D to the U.S. Economy

QUESTION: 4. What system, if any, is being employed to determine whether the projects that have received ATP or TRP awards are successful? What are the results of any evaluations of any ATP or TRP projects that have been done?

From the start, ATP has strongly embraced program evaluation and considers it critical to the operation and long-run success of a results-oriented, efficiently run program. NIST's evaluation plan for ATP has provided a model for other industry-led cost-shared technology programs, including the Technology Reinvestment Project. Specific indicators of success, already being used to rate early impacts on participating companies from ATP's startup years, include: expanded R&D activity, particularly the ability to engage in high-risk, long-term research with high-payoff potential; cost and time savings, and improved productivity; improved competitive standing; formation of valuable strategic alliances; improved ability to attract investors; assistance in converting from defense to commercial applications; and acceleration of technology development, leading to improved market share.

For its contribution to the civilian industrial sector, TRP has modeled its evaluation plan largely on ATP's plan. For its major focus on military applications, TRP is developing a different, highly detailed evaluation plan. The ultimate test of the success of a dual-use technology program such as TRP will be the ability of the military to keep its technological edge, drawing from affordable, state-of-the art technologies from the commercial sector, and the commercial success of these same technologies.

It is not yet possible to assess ATP's full economic impact because it is too early for these effects to have occurred; the program began, on a very small scale, in 1990. Only a handful of early projects are out of the R&D phase and entering commercial development. NIST has put into place systematic mechanisms to gather data and

provide the analysis as the long-term effects unfold. These include an information collection system for tracking the business progress and economic results of ATP projects; case studies of individual projects; the experimental use of macroeconomic models for projecting outcomes; and development of methods to estimate the benefits that go beyond the award winners to the industry as a whole, consumers, and the economy. Early, small-sample studies do show that ATP has led to faster development of new technologies, reduced time to market, early progress toward commercialization, and company expansion and projections of future growth.

TRP has not yet conducted an evaluation of its entire program, which is still quite new (the first TRP awards were announced in October 1993, and the first actual agreements signed in early 1994). However, TRP managers continuously evaluate the progress of individual projects, to determine whether they are meeting deadlines and technical milestones.

QUESTION: 5. OSTP recently reported that the U.S. leads the world in science and technology, but that the lead is slipping relative to Europe and Japan. What were the main findings of the OSTP report and what must the U.S. do to strengthen its leadership in critical technologies?

The National Critical Technologies Report (March 1995) emphasized that significant improvements have been made in recent years resulting in U.S. leadership in most of the critical technology areas. However, this status must be viewed with an understanding of the highly dynamic nature of technology leadership in today's globally competitive environment. The report includes a competitive benchmarking assessment of the present U.S. position in each of the critical technology areas against major foreign competitors. This position reflects the impact of government policies and the performance of U.S. industry and universities over the past few years.

The current competitive position of the U.S. relative to Japan and to Europe is summarized for each technology area. The rate of change of the U.S. position is also provided and is considered equally as important as the current competitive position. This is a key input for technology policymakers in the Administration and in the Congress as they seek to maintain a strong U.S. position in critical technologies for future national security and economic prosperity.

Although the assessment of current status shows the U.S. position to be at parity with, or ahead of, the positions of Europe and Japan for all 27 of the critical technology areas, in most cases this U.S. lead is made tenuous by static or even negative trends relative to foreign competition. Compared to Japan, the U.S. was judged to have a substantial lead in 10 of the 27 technology areas, a slight lead in 11 areas, and to be at parity in 6 areas. However, Japan is outpacing U.S. progress in 5 areas where the U.S. currently enjoys a substantial lead and in 5 areas where the U.S. has a slight lead. The Japanese rate of progress is at parity with the U.S. in 9 areas, leaving 8 of the 27 areas where U.S. progress is outpacing the Japanese.

With respect to Europe, the U.S. was judged to have a substantial lead in only 1 of the 27 technology areas, a slight lead in 18 areas, and to be at parity in 7 areas (one area was not benchmarked against Europe). Europe is outpacing U.S. progress in 3 areas where the U.S. currently enjoys a slight lead and in 1 area where the U.S. and Europe were determined to be at parity. The European rate of progress is at parity with the U.S. in 16 areas, leaving 6 of the 27 areas where U.S. progress is outpacing the Europeans.

The Clinton Administration has redirected and reinvented the federal S&T enterprise through the National Science and Technology Council. One objective is to strengthen U.S. leadership in critical technologies while creating a stronger economy, better and more jobs, and a cleaner environment.

A significant component of the Administration's technology policy is the establishment of partnerships to advance national goals. Partnerships between the Federal Government, private industry, state and local governments, and universities, and other Administration programs, are advancing progress in many of the critical technologies covered in the report, including energy, environmental quality, information and communication, living systems, manufacturing, and materials.

QUESTION: 6. I support the ATP because I believe it provides critical "seed money" to companies that need an initial helping hand to get started and attract private capital. Nevertheless, it was surprising that, at a time when NASA and other R&D agencies are cutting back, the President requested $491 million for ATP in FY96, an increase of 14 percent over the FY95 level. Do you believe the budget treatment of ATP was overly favorable relative to that of other R&D programs?

Putting together a budget while meeting a commitment to reduce the federal deficit clearly involves difficult choices—often between programs of similar merit. Significant savings have been achieved in NASA through improved management and program design while meeting the agencies core commitments. We feel that growth in the ATP program is essential for ensuring the economic security of the U.S. in

a period where economic competitors around the world are in a tight race with U.S. producers. Many firms are being forced to reduce spending on precisely the kind of high-risk research funded by the ATP; the cost sharing available from ATP ensures that the U.S. will have the technology resources needed in the years ahead. The investment represents a small fraction of the savings achieved in other agencies.

Indirect Costs (Government payment of overhead costs)

QUESTION: 7. In recent years, universities and the federal government have been struggling with the issue of indirect costs. While it is only fair that federal government reimburse research grantees for some of the overhead, some colleges abused the system. In response, federal regulations were revised to impose a 26 percent cap on indirect costs. On March 6, the GAO issued a report on the effect of those regulatory changes. Among other things, the Report found that (a) the cap reduced indirect cost charges to the federal government and (b) it resulted in more uniform rates among universities.

What is your reaction to the Report and its findings? Does the Clinton Administration still view the matter of indirect costs as a major problem or has it been effectively resolved? Are there still cases of flagrant abuses among the universities?

We are pleased the GAO report confirms that, following the good work by the previous Administration, we are on the right track in refining the system for reimbursing universities for costs associated with federally funded research. We in this Administration have undertaken a comprehensive review of this issue, proposed revisions this past February and expect to have further revisions by the early part of next year. Following allegations of improper accounting and possible mismanagement several years ago, there were numerous audits of university financial systems. Universities changed their accounting procedures and federal negotiators toughened their approach. We no longer believe the matter of "indirect" costs, now called "research costs", is a major issue requiring congressional attention. We would be pleased to brief you further on this issue and the work we have in progress.

The previous Administration revised OMB Circular A-21 to cap the administrative component of indirect costs at 26% of total costs, tightened the definition of what costs would be allowed for federal reimbursement, and included several provisions to achieve greater uniformity among university practices. As a result of these 1991 and 1993 revisions by the last Administration, GAO found that:

- university rates are more uniform and procedures are more consistent
- federal reimbursement has been reduced by over $110 million annually
- the portion of total academic research funding by NIH and NSF attributable to facilities and administration (what we used to call "indirect costs ") has decreased over the past five years down to 31% and 22% respectively (meaning that on average, $0.78 of every NSF dollar is spent directly on research activities)

On February 6, 1995, we proposed revisions to A-21 to bring about further uniformity in methods and procedures. We also will change our terminology—past notions of " indirect" costs were needlessly complicated and poorly understood. What had been indirect costs will now be two categories—research facilities and research administration—both necessary to the conduct of fundamental research. Having capped the category for research administration, we have turned our attention to research facilities.

We now are working closely with OMB and the research community to develop simpler and more consistent ways to calculate appropriate costs for facility and utility use. The result of our work will be further revisions to OMB Circular A-21, probably to be offered by the early part of 1996. We hope to incorporate further incentives to keep research facilities costs down. However, we are mindful of the need for continued public and private investment in research facilities in order to maintain our world leadership position in science and train the next generation of scientists and engineers. A significant portion of the federal participation in this investment is through reimbursement of facility research costs. Therefore we are pleased that GAO found such a large majority of the individuals interviewed oppose a cap on overall indirect cost rates (consisting of administration and facilities) "because they believe a cap will adversely affect universities' ability to provide the modern laboratory facilities and equipment needed to perform advanced scientific research."

Coordination of multiagency science programs

QUESTION: 8. One of the most important responsibilities of your office is the coordination of the Nation's multiagency federal science programs, which address such matters as global change research, high performance computing and communications, and advanced materials.

QUESTION: 8. a) Would you identify the major multiagency science programs which your office is responsible for coordinating?

QUESTION: 8. b) How much of the FY96 budget is allocated to these programs?

The following are selected, major interagency science and technology programs supported in the current budget:

	FY1995 estimate	FY1996 proposed	Dollar change 95–96	Percent change 95–96
	($ millions)			
Technology Learning Challenge	328	335	+8	+2%
Partnership for a New Generation of Vehicles	246	333	+87	+35%
Construction & Building	141	169	+28	+20
Physical Infrastructure for Transportation	247	321	+74	+30%
Environment & Natural Resources *	5,339	5,536	+197	+4%
U.S. Global Change Research Program *	2,118	2,157	+39	+2%
High Performance Computing and Communications	1,080	1,142	+63	+6%

* U.S. Global Change Research Program is a subset of the Environment and Natural Resource initiative.

NSTC Technology Learning Challenge (TLC): The TLC is a partnership with industrial, educational, and training institutions using computers, new communication systems, and other advanced technologies to improve the quality, accessibility, and productivity of learning experiences for all Americans. The budget proposes four major focus areas (innovative technologies and demonstration projects, learning tools, evaluation techniques, and cognitive process research). For 1996, nine agencies are proposing $335 million for this effort. An Interagency Technology Office, established within the Department of Education, will carry out the initiative.

Partnership for a New Generation of Vehicles (PNGV): The PNGV or "Clean Car" initiative is a partnership with U.S. industry to ensure the global competitiveness of the U.S. automobile industry and its suppliers and improve environmental quality. It is structured around two near-term goals—better manufacturing technologies and better emissions control of conventional engines—and a major long-term goal—developing an attractive, affordable car with three times the fuel efficiency of today's vehicles.

The budget proposes investments in 14 technologies, targeting most Government funding to the third, long-term goal. Eight agencies participate in the initiative: the Departments of Commerce, Defense, Energy, Interior and Transportation, and EPA, NASA, and NSF. Their combined budget proposal is $333 million in 1996, an increase of $87 million or 35 percent above 1995.

NSTC Construction and Building (C&B): A partnership with U.S. industry, C&B is designed to improve the productivity and safety of building construction practices and the affordability, quality, and environmental characteristics of buildings. C&B has set goals and priorities in three broad areas: technology improvements, such as information and decision technologies; non-technical barriers to improvements, such as regulatory barriers; and the deployment of technology, including training and demonstration projects. Seven agencies are proposing $169 million in 1996, an increase of $28 million (20 percent) over the 1995 level.

NSTC Physical Infrastructure for Transportation: This partnership with industry is designed to improve the quality and lower the cost of building and maintaining highways, bridges, ports, rail lines, airports, and other parts of the Nation's physical transportation infrastructure. The budget provides funds to expand programs associated primarily with accelerating R&D on new materials and with the methods of assessing infrastructure conditions. For 1996, five agencies are proposing $321 million, an increase of $74 million, or 30 percent, over the 1995 level. R&D activities include airport security and pavement technology, and research and technology in highway materials, pavements, and structures.

NSTC Environment and Natural Resources (ENR): The ENR initiative focuses on R&D programs associated with global change, biodiversity and ecosystems, air quality, natural resources and management, water resources, coastal and marine resources, toxic substances, hazardous and solid wastes, and natural disaster reduction. Twelve agencies propose $5.5 billion in 1996, an increase of $197 million or four percent over 1995. The total for ENR includes $2.2 billion for the U.S. Global Change Research Program (USGCRP).

NSTC High Performance Computing and Communications (HPCC): The HPCC program involves nine agencies and is designed to ensure U.S. leadership in information and communications technologies and help lay the technological foundation for the National Information Infrastructure initiative. It supports research on computer science and engineering, and the development of applications of information technology in commerce, manufacturing, education, public safety, health care, and

other fields. The budget proposes $1.1 billion for HPCC in 1996, an increase of $63 million or six percent over 1995.

QUESTION: 8. c) How does OSTP perform its coordination function and what role does the National Science and Technology Council play in that regard?

In order to confront the budgetary, scientific, and technological challenges of the 21st century, the Administration recognized that significant changes were needed in the way we plan and fund Federal R&D. The traditional single-agency, single-discipline approach to problem solving must be supplanted by a coordinated, multi-agency, interdisciplinary approach. Multi-dimensional problems can only be addressed by bringing together natural and social scientists, economists, engineers, and policymakers. For too long, science has been decoupled from informing policy decisions. Fixing this disconnect has been one of our highest priorities.

Over the past two years, the Administration has been working to improve the Federal R&D enterprise in many ways. For the first time, the United States has a comprehensive, coordinated Cabinet level body devoted to coordinating the Federal R&D enterprise. In November 1993, the President created the National Science and Technology Council (NSTC). The principal purpose of the NSTC is to:

- identify national goals that require concerted R&D efforts;
- identify the high-priority R&D needed to meet those goals; and
- coordinate R&D government wide to make sure that adequate attention is given to high-priority areas, and to avoid wasteful duplication

Although each agency, to accomplish its missions, must have R&D directed to its particular needs, there are some commonalities in the science and technology needs of all the agencies. Put another way, overarching national goals typically cross agency boundaries. This is particularly true because of the highly interactive nature of research and development with its many feedback mechanisms. The NSTC provides a structure in which to prioritize the many legitimate demands on the public's R&D dollar. It assures a forum where critical national needs cannot be pushed aside by urgent and parochial agency needs. It can sensitize agencies to the advantage of symbiosis over isolated pursuit of objectives.

Through its nine standing committees, the NSTC has identified R&D priorities that link our S&T activities to critical national goals. The nine NSTC standing committees are organized in the following principal areas: fundamental science; health, safety, and food; environment and natural resources; information and communications; national security; civilian industrial technology; transportation; education and training; and international science, engineering and technology. They produce strategic plans that set forth each program's major scientific objectives. They also develop implementation plans that set forth the contributions (milestones, deliverables) of each of the participating agencies' individual research programs and projects. Development of these strategies and implementation plans enables agency program managers to identify both programmatic overlaps (which would lead to duplication) and gaps (which could lead to the inability to meet scientific program objectives), and to effectively redirect resources to address research needs.

Some programs, such as the U.S. Global Change Research Program, have established a working group structure and a small coordinating office to facilitate interagency coordination.

They seek to establish effective coordination with related national and international scientific activities at universities and industry laboratories, for example, as well as to make sure that the research programs are addressing issues of concern to various stakeholder groups such as industry, non-governmental organizations, state and local governments, and the Congress.

Specific activities of the Committees include: (1) initiating scientific planning efforts as required; (2) tracking program progress, identifying problems or gaps and recommending solutions; (3) developing, reviewing and disseminating information products that describe program goals and accomplishments; (4) complying with any statutory requirements, such as the development and routine revision of a ten-year research plan; and (5) ensuring consistent, interagency compliance with Executive Branch directives and requirements such as the annual OMB budget crosscut and regular reports to NSTC and OSTP;

Unprecedented cooperation among the member agencies in 1994 enabled these committees systematically to prepare research and development strategies to meet the goals. OSTP worked with the Office of Management and Budget to ensure the priority areas received adequate attention—all within a level R&D budget. The result is a coherent, efficient R&D agenda.

To meet the Nation's goals in the years ahead—and to continue meeting them as the goals evolve—requires that we set priorities for R&D now, with a farsighted vision for the future because most of the S&T enterprise is inherently a multi-decade process. Even within the science community, it can take decades to recognize the

significance of a scientific discovery. The NSTC provides the mechanism for providing the vision and deriving priorities. By creating a "virtual" S&T organization, the NSTC enables the Administration to maintain a productive research and development activity in each S&T-dependent agency while simultaneously achieving the efficiencies of a cross-linked system.

Space

QUESTION: 9. In the Apollo era, NASA's mission was clearly focused on human exploration of the moon. Recently, defining its central purpose has been more difficult.

QUESTION: 9. a) How would you explain to the average taxpayer in Montana why the government should pay $14 billion for a space program?

The programs and activities conducted by NASA are dedicated to three primary missions:

1) Explore, use, and enable the development of space for human enterprise, 2) Advance scientific knowledge and understanding of the Earth, the solar system, and the universe and use the environment of space for research, and 3) Research, develop verify, and transfer advanced aeronautics, space and related technologies.

In pursuing these missions, NASA's programs contribute to critical national goals including economic growth and competitiveness, job creation, protection of the environment, educational achievement, and world leadership in basic science, mathematics, and engineering.

NASA's investment and research in aeronautics and aviation contributes significantly to the commercial aviation industry including export sales of $40 billion and a $30 billion positive balance of trade, and supporting 1 million high-quality jobs in the aircraft manufacturing and airline industries. NASA's research specifically has led to advances and improvements in quieter, cleaner, and more fuel efficient engines that saves resources and reduces environmental pollution.

The Agency's space satellites and probes deployed to understand planetary phenomena have revealed startling discoveries about fundamental science, the age, origin, and nature of the universe, and the evolution of other planets. These missions of discovery help the Nation maintain science leadership, excites and inspires society, and strengthens education and science literacy. As is the case with other Federally supported science programs, the basic research that is conducted in the development of these missions leads to societal benefits that can not be predicted or planned for.

The same technologies that are integrated into probes that look to outer worlds are also used in the development of spacecraft that are directed at the study of our home planet. Such spacecraft are designed to understand Earth as a total system and the effects of natural and human-induced changes on the global environment. The unique advantage point of space provides information about Earth's land, atmosphere, ice, oceans, and biota that is obtainable in no other way. Information obtained from Earth science research will be used to support the complex environmental policy decisions that lie ahead and are of importance to all citizens.

NASA's activities related to human space travel, as manifested in the space shuttle and the space station, are designed to bring the arena of space fully within the sphere of human activity for the benefit of America and all humankind in this and future generations. Research conducted today on space shuttle missions, and those investigations planned for the space station lead to breakthroughs in technology and engineering that have immediate, practical applications for life on Earth in disciplines such as medical research and microgravity and materials science.

The $14 billion that is invested in the Nation's space program represents less than one percent of the total Federal budget, a small investment for a program that has relevance and makes a contribution to the past, present, and future.

QUESTION: 9. b) For the next generation, what should be the defining mission of NASA—human habitation of the Moon, human spaceflight to Mars, or some other goal?

Each generation must define its own objectives according to its resources and its needs. Space research and breakthroughs from present experimentation may lead science in directions which are impossible to predict. Moreover, future affluence or economies may impact the nation's level of investment. Certainly there are compelling reasons to go back to the Moon, and to undertake human missions to Mars. Equally important, however, are the investments necessary to maintain America's competitive edge in space and aeronautics. The need to keep U.S. aerospace industry in the world's forefront, to develop cutting-edge technologies in aeronautics, to regain our lost share of the space transportation market, and to otherwise assure

American preeminence in science and engineering, must continue to be fixed goals of succeeding generations.

QUESTION: 10. (a) What is your assessment of the Space Station program?

Since the Space Station redesign effort in 1993 the new program has kept to schedule and cost targets. The first element launch date of November 1997 remains intact. All major design reviews and technical milestones have been accomplished on schedule. Phase I of the program is well under way with two Russian cosmonauts having flown aboard American Space Shuttle Missions, and an American astronaut presently working aboard the Russian Mir space station. A Shuttle rendezvous with Mir has been successfully accomplished, and a Shuttle-Mir docking and crew exchange will occur in June. In summary, all progress and events have reaffirmed our confidence in the soundness of the concept and design, and the cooperative ability of the partners to work together and succeed.

QUESTION: 10. b) What do you believe its major scientific benefits will be?

Predicting the results of laboratory research is highly speculative and uncertain. However, the following enumerates some of the objectives to be pursued in two general fields of science: medical research—better understanding of many functions of the human body, research into pharmaceutical, smaller and more highly-capable medical tools and instruments, new insights into human health and disease, and understanding of the effects of long-term exposure to zero gravity for extended space flights; technology and engineering—new insights into industrial processes, fluid dynamics and combustion, metal alloy solidification, chemical storage, long-life power converters, waste management and recycling, robotic and telerobotic systems technology, lightweight structures integration of communications and telemetric data, and new polymers, semiconductors, and high-temperature superconductors;

QUESTION: 10. c) In your view, what are the advantages and disadvantages of the Russian participation in the program?

Russian participation is a thoroughly positive element of this program. Their partnership saves the U.S. some $2 billion in assembly costs, produces a station that has more volume, a larger crew, more power, and comes on line earlier than the previous design. Moreover, this concept helps promote the Democratization of Russia, stimulates its market economy, and facilitates Russia's entry into the world's family of free nations. Unexpected and unanticipated political reversals in Russia would constitute a disturbance to the Space Station program, but contingency plans have been developed to help offset the effects of such an unlikely prospect.

QUESTION: 10. d) Are you disturbed by recent reports that the Russians and the Europeans appear to be balking at future commitments to the Space Station Program?

As a result of the Space Station Redesign effort and the decision to invite Russia to join the program in 1993, as well as shrinking space budgets in Europe, European participants asked ESA to reassess its contribution to the program. This reassessment was conducted throughout 1994, and during its March 22-24, 1995, Council meeting, ESA could not reach firm agreement on funding for its anticipated contribution to the international Space Station program. This contribution consists of the Columbus Orbital Facility (COF), a pressurized laboratory, and the Ariane-5/Automated Transfer Vehicle (ATV), a vehicle for the transport of pressurized and unpressurized logistics.

The present uncertainty surrounding the European commitment to the program involves the extent to which individual European participants will financially support the ESA package. The big four member states of ESA (Germany, France, Italy, and Belgium) have separately conveyed, at executive and agency levels, their support for a continued European role in the program; however, they face budget environments similar to that of the United States. In addition, the interplay of nine different budget cycles adds an additional challenge, as budget decisions are on different timetables for each country. For example, Italy indicates that its government cannot commit funds until the Fall of 1995.

For this reason, ESA did not secure complete financial and legal endorsement of its Space Station elements at the March Council. However, the United States is hopeful that ESA will achieve European consensus on its Space Station contribution later this year. The financial and legal endorsement is expected to follow in October at the ESA Ministerial-level meeting.

Since October 1992, when NASA and the Russian Space Agency (RSA) signed the first agreement on human space flight, expectations have been backed up by real achievements. In this short time, two Russian cosmonauts have flown on board the U.S. Space Shuttle, and NASA astronauts have been in training in Russia for over a year. Most recently, Astronaut Norm Thagard became the first American to fly on board a Russian spacecraft, and at this moment he is carrying out duties as a crew member on the Mir space station.

89-788 - 95 - 5

Russia is also living up to its commitments on the international Space Station. Nearly 85 per cent of the design drawings for the Functional Cargo Block, the first element of the station to be launched into orbit, are already complete. Coordination between NASA, RSA, and Russian subcontractors has grown steadily, with frequent meetings and teleconferences between managers and technical experts at the working level, as well as regular reviews for senior management.

Russia is clearly going through a difficult period as it continues to move toward a market economy and to develop and strengthen democratic institutions. The Russian government, including President Yeltsin and Premier Chernomyrdin, has demonstrated strong support for the space program. There is no indication or reason to expect future political developments in Russian will lessen that support.

QUESTION: 10. e) Do you agree that, if Space Station is not successful, the U.S. will find it difficult to find foreign partners for future joint science projects?

The International Space Station program is the largest international peacetime cooperative program ever undertaken, and could well be the model for similar future enterprises of a large and complex nature. If the United States were to fail to execute its obligations, however, the effect on this nation's credibility and stature in the international community would be catastrophic. The international partners have been patient and loyal to the program throughout a long and convoluted history of schedule changes, redesigns and re-negotiations. To abandon this program at this juncture would surely be regarded as an unforgivable breach and would certainly have a profound effect on any future undertakings of a similar nature.

QUESTION: 11. The Space Shuttle relies on 1970's technology and costs over $400 million per launch to fly. For that reason, NASA is proposing a new program aimed at developing a Shuttle replacement.

QUESTION: 11. a) What is your view of the Reusable Launch Vehicle (RLV) initiative? How important is it that the aerospace industry share the cost of developing any test or operational RLVs?

The RLV program will develop the technology we need to replace current space launch systems—which are complex and costly to operate—with a new generation of low cost reusable launch vehicles. The Reusable Launch vehicle technology program is underway. In March 1995, the Administration announced a cooperative agreement with three industry teams to begin preliminary design work on a next generation launch system which might eventually replace the Space Shuttle. This program is one of the Administration's most important space initiatives as it focuses on development of new technologies and operational techniques which will radically reduce the cost of access to space.

Through the RLV program, we are building government/industry partnerships that will be a key component in developing an efficient and affordable system. These partnerships should take advantage of both the ability of the Federal Government to pursue "high-risk" technologies and the inherent efficiencies that are typically available within the private sector. Clearly, however, the involvement of the private sector should be structured in such a way that true savings will result to the Federal Government. Likewise, major commitment or guarantees should be made to the private sector for the commercial development of an operational vehicle only when there is significant confidence that the parties involved will deliver on their commitments, including vehicle performance, cost and efficiencies. As the President's policy notes, we will be looking at these issues as part of our overall decision in December 1996 on whether to proceed with development of a subscale RLV demonstrator.

QUESTION: 11. b) Do you believe the pressure to cut costs at NASA may threaten Shuttle safety?

Safety is always a concern to everyone involved in the Shuttle program. The cost-cutting exercises that NASA has been involved in for the past three years have not been at the expense of safety. In fact, they have been accompanied by a reduced number of in-flight anomalies, ground mishaps, and quality problems. The hardware and operations have matured, even as the numbers of people required to safely run the program have come down. As NASA looks to further funding challenges in the future, it has been made clear that safety will not be sacrificed for the sake of efficiencies.

QUESTION: 11. c) What is your assessment of proposals to privatize the Space Shuttle and other NASA programs?

Not enough information is presently available to fully assess privatization of the Shuttle program. However, as restructuring options are formulated and assessed, the possibility of privatization is being considered. Among these is an option to transition Shuttle operations to a single prime contractor. The options focus on reviewing the Program requirements and management structure in light of the increasing maturity of Shuttle operations and the fact that most of the hardware upgrades development will be completed by fiscal year 1998. Options include elements of civil

servant down-sizing, safety and mission assurance reallocation, transition of operational responsibilities to contractors and consolidation of activities with the Space Station Program. The transition timing from today's program structure to a new structure will be key to its success. A working group has been formed to review and integrate the findings and recommendations of all the reviews and studies associated with restructuring the Space Shuttle Program. The results of this effort are expected in late May.

QUESTION: 12. What are the expected benefits of NASA's Mission to Planet Earth program and the larger federal global change research initiative?

The goal of the U.S. Global Change Research Program (GCRP), which includes NASA's Mission to Planet Earth (MTPE), is to provide the scientific and technical information that will allow us to protect the environment and human health, while realizing economic growth, job creation, and enhanced national security. The knowledge generated from these programs will be used to assess the impact of human activities on the environment; the consequences for human health, ecological systems, and socio-economic sectors including agriculture, forestry, fisheries, and water resources; and the effectiveness of various adaptation and mitigation strategies. Thus these programs will provide governments and the private sector the scientific basis required for informed, equitable and cost-effective national and international policy formulation on a variety of issues including climate change, ozone depletion and land-use. For example, farmers, foresters, water and natural resource managers, and state and local governments will be able to use this information to devise strategies that will allow them to become more resilient to natural climate variability (e.g., floods, droughts, and heat waves) and extreme events (hurricanes, tornadoes and cyclones), and will allow them to devise strategies for mitigating or adapting to human-induced changes in climate.

The GCRP is a fundamental scientific program that focuses on how the Earth system varies in response to natural phenomena and human activities. The GCRP, which was initiated by President Reagan, significantly expanded by President Bush, and continues to be strongly supported by President Clinton, was begun in response to increasing evidence of global scale changes in the Earth system and the realization of the significance of the potential consequences of such changes. The program is focused on four global scale environmental issues: climate change and greenhouse warming; interannual climate variability; ozone depletion and UV radiation; and land use and land cover change. In each area, the research effort is aimed at observing, documenting, and monitoring global scale changes, developing an understanding of the causes and mechanisms of change through studies of Earth system processes, developing a predictive capability through modelling and analysis of the components of the Earth system and their interactions, determining the consequences of change, and assessing the effectiveness of mitigation and adaptation options.

Climate change research can help us avoid the potentially significant adverse effects of natural climate variability (seasonal and interannual time scales) and human-induced changes in climate (decades to centuries).

Natural Climate Variability: Largely due to work undertaken in support of the Tropical Ocean Global Atmosphere (TOGA) project of the World Climate Research Program (WCRP), and the measurements of the NASA-French Satellite Ocean Topography Experiment (TOPEX)/Poseidon, we have developed the ability to monitor and forecast El Nino events, and have begun developing the ability to forecast the consequences (on agriculture, human health, water resources, and natural resources) of these events. The consequences of these events are truly global in scale, affecting precipitation patterns in North and South America, Africa, Europe, and Australia. Farmers in North and South America are already using research forecasts in planning, and hydropower authorities are using the same information to better manage the water drainage budgets in Brazil. We expect that these forecasts will become a routine operational product that supports effective decisionmaking in crop selection, planting and harvesting, as well as helping mitigate the effects of extreme weather events such as droughts and floods. Better information and forecasting can help us deal more effectively with natural variability.

Global Warming: Recent advances in modelling have resulted in successful simulations of the transient cooling of the lower atmosphere in response to sulfates emitted by the eruption of Mt. Pinatubo, and in an improvement in the accuracy of historical climate models over the last 100 years. We are seeing a marked improvement in the ability of models to deal with the incredible complexity of atmospheric, oceanic and terrestrial processes, and we expect to see the development of fully coupled Earth system models within the next decade. When combined with our ongoing improvements in remote sensing and in-situ observational capabilities and data management, this will enable us to accurately predict the magnitude and the regional consequences of climate change. The impact of changes in climate on

human health, natural ecological systems, and socio-economic sectors such as agriculture, forestry, fisheries, water resources, and human settlements could be greatly reduced by a predictive capability.

Science

QUESTION: 13. Similar to the debate about industrial policy, policymakers argue about the merits of basic research versus "strategic research"—that is, research aimed at some important national need. What is your position on this subject? Does basic, curiosity-driven research suffer when too much emphasis is placed on strategic research?

The proliferation of such terms as "basic", "strategic", and others to describe research has added much confusion to an already complex topic. Much of the confusion stems from a desire to assign distinct, mutually exclusive definitions to activities that are inherently overlapping and integrated.

Federal support for civilian scientific research is almost entirely for basic research. Further, the preponderance of the research are in areas of clear importance to the nation. We would prefer to identify this approach as "research in strategic areas." Excellent research in strategic areas is not different from the traditional curiosity-driven or basic research that has produced many of scientific breakthroughs. The emphasis on research in strategic areas is entirely consistent with a traditional commitment to basic research. Thus "strategic" and "basic" are not either/or categories.

Virtually all of the research funding provided by agencies such as the National Science Foundation (NSF) is focused on unanswered questions in science and engineering with unpredictable outcomes. Yet this research is often simultaneously influenced or inspired by current problems and potential applications. Basic research in computational geometry, for example, shares a close relationship with many industrial challenges—such as virtual prototyping, virtual manufacturing, and networking of laboratories and factories.

In our view, there must be a balance between research in areas of obvious strategic importance to the nation, and research in other areas of science, whose contributions are not as easy to foresee, because we may be surprised by its contributions in the future. There must also be appropriate balance across scientific areas. We think the FY96 budget does this.

QUESTION: 14. Some segments of the scientific community have argued that "Big Science" programs like Space Station drain needed federal funds from the "Small Science" programs which favor academic research. Do you agree with that view? How do we develop a proper balance between Big Science and Small Science?

The "Big Science" versus "Little Science" issue is one that comes to the fore from time to time but most often when a large and costly project is under consideration. The federal government is not wedded to a particular way of doing science—it is committed to maintaining leadership across the frontiers of scientific knowledge and to producing the finest scientists and engineers for the twenty-first century. Meeting these objectives at any particular time requires a mix of the highest quality of both big and small science. We believe that we are very nearly at the appropriate balance point between what are referred to as "Big Science" and "Small Science" consistent with the commitments listed above.

In drawing up the federal science budget, the OSTP, OMB and the federal agencies address the issue of this balance. For example in preparing the FY 1996 President's budget, it was felt necessary to add resources to increase the utilization of the large user research facilities operated by the DoE for the nation's R&D community. These facilities are developing a serious backlog of first rate experiments that had been proposed by their respective user communities. Providing the incremental funds that allow several thousand scientists effective access to the research facilities of their choice is a prudent investment of federal funds and will greatly increase the overall store of scientific knowledge and will serve to provide vital research experience to hundreds of young scientists. Does this represent support of "Big Science" because the facilities are large or is it support of "Small Science" because it allows university researchers and their students to carry out the research of their choosing which requires resources uniquely available at these large facilities? The issue should not be cast in terms of small versus large, but rather one of how the U.S. remains at the forefront of research and effectively train tomorrow's scientists and engineers with available resources. This is a challenging issue on which we continually seek input and advice from many quarters.

QUESTION: 15. Several years ago, we used to hear that the U.S. was facing a severe scientific workforce shortage. In fact, there was a prediction of a shortfall of scientists and engineers by the year 2006. However, last year, a Washington Post se-

ries suggested that there is a huge number of researchers chasing a handful of research grants. Which is the more accurate depiction of the current and future supply of scientists and engineers to handle the Nation's R&D demands?

The issue of workforce supply of scientists and engineers has been raised a number of times over the years. The earlier prediction of a scientific workforce shortage, as well as the recent observation that research grant funding is increasingly competitive, are both valid depictions. These depictions, however, reflect only the supply of scientists and engineers within the academic job market, and do not address the issue of employment of these professionals throughout the broader workforce.

Earlier discussions about a scientific workforce shortage were predicated on the prediction that in the early 21st century, there would be high demand for scientists because of pending retirement of university faculty. Looking at the age pyramid of university faculty across the nation, it was logical to expect an excess of academic positions and an insufficient pool of candidates. Given the current fiscal health of universities, however, these replacement positions have not materialized in the numbers expected. The reduction in job availability appears to reflect attrition in faculty positions. While faculty are retiring, as predicted, their vacated positions are not being filled, and the teaching burden is being distributed across existing faculty. Further, major public institutions are faced with the twin problems of enrollment decline and shrinking state support. For all of these reasons, the academic job market is not expanding at a rate commensurate with our production of scientists and engineers. In addition to the dearth of university positions, it is also true that the rate of growth of research funding is slow and has not kept pace with the increasing demand and competition for funds. At NSF and NIH, for example, the percentage of approved grants that receive funding has decreased over time.

The paucity of academic positions and the difficulty in acquiring federal research grants should not necessarily be interpreted as reflecting an overproduction of scientists and engineers. A broader view of the production issue is that scientists and engineers receive training that prepares them for a much wider selection of employment opportunities. Education in science and engineering develops skills and talents that are useful outside of academia. Just as law students have learned that practicing law is only one available employment option, science and engineering students must learn to pursue the jobs outside of academia. The world is relying increasingly on science and technology for economic growth and job development. The future job market for scientists and engineers may not be growing in academia, but there is increasing demand in industry. Indeed, the data suggest that job growth occurring in industry is faster than in academia. The number of jobs for Ph.D. scientists and engineers in industry rose by 18% between 1987 and 1991. Indeed, the job market for scientists and engineers has expanded from academia and now includes growing opportunities in industry, on Wall Street, and in management.

QUESTION: 16. Many believe that the science and math skills of our Nation's young people lag behind those of their counterparts in many other countries. Is this true and, if it is, what policies should the federal government adopt to turn this situation around? What lessons can the U.S. learn from the science education programs of Japan and other foreign countries and how does the U.S. approach differ from theirs?

Over the years, research on science and math education has focused increasing attention on cross-cultural differences in achievement and educational programs that might improve the academic performance of U.S. students. According to a 1992 study of cross-national achievement scores in mathematics, U.S. nine-year olds score significantly below their same-age counterparts in several other countries. Yet the achievement scores for science suggest that U.S. nine-year olds score at a level commensurate with students in other countries participating in the study. High school achievement was less optimistic, with U.S. thirteen year-old students scoring below students from a wide range of countries in both science and mathematics. Differences in scores most likely reflect a complex interaction of factors, including curriculum differences, resources, and cultural values and expectations. Preliminary data, from a study in progress, suggest that science and mathematics curricula in the United States are broader than in many other countries, thus resulting in a unique burden on teachers who must offer instruction in a wide array of topics. Within the United States, achievement scores vary greatly. The primary differences among American students appear to represent economic differences and resource allocation to education. Differences between states, and racial and ethnic differences, for example, appear to be attributable to these economic factors.

The National Science Foundation and the Department of Education have developed programs to improve K-12 science and mathematics education. These programs support local and state efforts to improve and reform education, and include programs of systemic reform, curriculum development, professional development for

teachers, and the creation of hands-on learning opportunities for children and for teachers. The National Academy of Sciences and the science and mathematics communities are also active in these programs and in related activities. In the past several years, we have begun to see the benefits of this attention to science and mathematics education. Since 1982, scores have increased on a variety of science and math achievement measures. Enrollment in high school science and math courses has increased. And in the past few years, there has been an increase in the number of teachers who have taken advanced mathematics courses, but a comparable increase for science teachers has not been evident. It is clear that many of our students are benefitting from programs and policies that already exist, even though many of these programs and policies are not widely used. "Hands-on, minds-on" experiences for students and for teacher professional development, for example, have improved the achievement of students, the competence of teachers, and the motivation and excitement for both groups, even though this approach is not widely implemented.

Current research efforts to evaluate the cross-national differences in education systems will include an examination of the Japanese system. The results are expected to be complete by 1996. The pending study notwithstanding, there are some comparative issues that should be mentioned. Primarily it is known that our educational system for science and mathematics is not balanced. Our university programs are the best in the world, as evidenced by the influx of foreign students who request admission to U.S. institutions of higher learning. Further, the Japanese are concerned that their system stifles creativity and imagination and they are looking at our system to learn how we produce innovative scholars. It is our system of elementary and secondary education that shows the greatest comparative weaknesses. Our very best K-12 students, however, appear to perform as well as their counterparts in other countries. The primary weakness of our system appears to be in the education of our general student body. It is believed that systems (and cultures) such as the Japanese are more regimented and result in more efficient learning of basic information. When the 1996 report becomes available, we should gain a better understanding of the components of the foreign systems that promote better learning of science and math for the general student body, as well as a deeper understanding of the strengths and weaknesses of our own system.

National Laboratories

QUESTION: 17. Our system of 700 federal labs is an enormous national asset. However, some critics argue that, in this post-Cold War era, many of the labs have outlived their usefulness and are simply perpetuating themselves.

How do make the labs more relevant to the post-Cold War needs of our Nation? Do you believe that the labs' basic research proposals should compete with our Nation's research universities?

The three largest Federal laboratory systems, those of the Department of Defense, the Department of Energy, and the National Aeronautics and Space Administration, account for at least three-quarters of what the Federal Government spends in its laboratories. These three systems were each reviewed individually over the past year or two, and they are the subject of an interagency review by the National Science and Technology Council that is virtually complete but not yet published. The individual reviews concluded that each agency's laboratory systems are able to meet important national needs of the post-Cold War era. The DOD labs are aimed primarily at meeting national security needs. DOE labs have important missions in basic and applied energy research, national security, environmental science and technology, and fundamental science. NASA Centers meet national needs in aerospace science and technology, and astronomy, astrophysics, and earth sciences.

For example, NASA's four aeronautical Research Centers conduct research and technology activities to address key national requirements related to aviation safety, environmental compatibility, and air transportation infrastructure capacity and productivity. In addition, these Centers conduct longer-term, higher-risk research in basic aeronautical technologies to help keep the United States competitive in aeronautics and aviation. NASA's Research Centers also provide critical research infrastructure—wind tunnels, computers and simulators, research aircraft, and propulsion test facilities—to a range of government, industry, and university users. All of these activities are conducted in close cooperation with NASA's government, industry and academic customers and partners to ensure that highest-priority requirements are being addressed in the most cost-effective manner.

These laboratories have some very important special capabilities in fundamental science. The DOE labs possess large facilities—mostly too large for universities or industry—that support basic research in physics, chemistry, materials science, and

certain areas of biology and earth science. NASA conducts certain research in astronomy, astrophysics, and the Earth environmental system, that depend entirely on NASA facilities, such as the Hubble Space Telescope. Most of DOD's support for science goes to universities, but some research that is especially relevant to defense, or requires large facilities, is done in DOD labs. All three agencies support university science, though DOE spends a larger proportion of its science funding in house than the others do. In a time of tighter budgets, all three may need to guard against a natural institutional tendency to preserve science activities in house.

QUESTION: 18. In February, a special task force chaired by Motorola CEO Galvin released a highly critical report on the DOE labs. One of the report's recommendations is to "corporatize" the labs system. The Report recommends establishing a not-for-profit corporation to manage and allocate funding throughout the DOE labs system.

QUESTION: 18. a) What do you thing of the Report's recommendation that the DOE labs system be run like a corporation? What are the advantages of this approach over the current system of management?

We do agree with the conclusion of the Galvin Task Force that governance by the Department of Energy of its major laboratories is broken and must be repaired. The government-owned, contractor-operated system that once offered flexibility and freedom from red tape has become so burdened with orders, directives, audits and reviews that the labs' scientific work is suffering severely.

We agree with the diagnosis. While the prescription—to "corporatize" the labs—has an immediate appeal, it also raises significant concerns. It would seem to require that Congress cede a substantial measure of authority over federal R&D spending and a loss of accountability for public funds.

Another approach—one that the Galvin Task Force recommended as an alternative—is aggressive action by DOE to put its house in order. And in fact, DOE is drastically reducing and simplifying orders and directives to its laboratories, and limiting its own reviews and audits of the labs. DOE is also reinventing itself as an agency, removing layers of management and improving efficiency.

In addition, a new Laboratory Operations Board, composed of senior department officials and distinguished private sector advisors, will provide high-level strategic direction for the labs; develop a mission statement for the lab system and tightly focused missions for each lab; and monitor the department's progress in lifting bureaucratic burdens from the labs. The result should be greater efficiency, less wasteful duplication, and a focus by each lab on work that exploits its best capabilities and contributes to post-Cold War national needs.

QUESTION: 18. b) What is your view of the [Galvin] report's findings and recommendations in general and is it appropriate to apply them to non-DOE federal labs? Does the Administration plan to implement any of the Report's recommendations?

The Galvin Report's findings are quite specific to the DOE labs. Most of the recommendations would be hard to generalize, especially those related to DOE governance of its labs, since DOE labs are government-owned and contractor-operated (GOCOs), whereas most other government-owned labs are government-operated (GOGOs). However, NASA labs were also reviewed by an external task force, chaired by Dr. John Foster. DOE and NASA are both aggressively carrying out most of the recommendations made by their respective Task Forces. The Administration expects them to carry these efforts through to completion.

Joint Industry-Government R&D

QUESTION: 19. I believe the joint research being done under Cooperative Research and Development Agreements (CRADAs) between the federal labs and industry is one of most effective technology transfer mechanisms. What can the federal government do to encourage more companies to do joint research with government?

One way to encourage more joint research with private companies is to apply our streamlining and reinvention principles to the CRADA process. The number of CRADAs approved has risen steeply since 1993, reflecting our initial efforts to simplify and improve the process by which these agreements are made. In addition to developing model, modular CRADAs with preapproved terms and conditions (easing the burden on researchers and ensuring a certain level of consistency and fairness in the agreements), the Administration's continuing efforts include: making it easier for industry to find the right technical capabilities throughout the federal complex; working with industry sectors to define partnerships that address their most important common problems; developing better metrics to measure the outcomes of CRADAs; and continuing to streamline and ensure consistency in the CRADA process.

QUESTION: 20. a) What procedures are in place to evaluate the benefits of the CRADAs?

The evaluation system for CRADAs includes measures of: the process, including the time it takes to conclude agreements; the results, including the technical outcomes of individual projects, the meeting of milestones and the generation of intellectual property; and the impacts, including such things as jobs created, gross sales, environmental benefits, energy efficiencies, or improvements in health care.

QUESTION: 20. b) Do we have any way of measuring the value of the federal government's contribution to individual CRADAs?

DOE labs are the most active among Federal labs in CRADA participation. They measure their contribution to individual CRADAs on a total cost basis, including overhead. This includes expenses that can be directly attributed to the CRADA work, such as salaries of investigators and the cost of supplies used, as well as indirect expenses such as supervision, general overhead and depreciation of capital assets. As of May 16, 1995, DOE labs were partners in 1332 CRADAs. The total value of these agreements was $2,341,768,084, of which the Federal share was $1,013,357,528, or 43.3 percent. Most DOE CRADAs require at least a 50 percent contribution from private sector partners, although there are exceptions, as for instance for small businesses.

DOE labs are government owned and government operated (GOCOs). Some government-owned government-operated laboratories (GOGOs) are more flexible in the required contribution from partners. For example, the laboratories of the National Institute of Standards and Technology do not require a set percentage, but vary the proportion case-by-case; the Federal share might vary from 5 percent to as much as 90 percent, depending on the purpose of the CRADA in relation to NIST missions. In general, the Federal contribution is counted in much the same way as in the DOE labs, that is, it includes both direct and indirect expenses.

Information Superhighway

QUESTION: 21. The information superhighway has the potential of dramatically changing the way we work and live. The superhighway will be of particular benefit to people in rural states like Montana, who will be able to take advantage of telemedicine, telecommuting, wireless communications, and other enabling technologies.

QUESTION: 21. a) What is the status of the national effort to construct an information superhighway?

The Administration has made the creation of the National Information Infrastructure (NII) a top priority. The information superhighway—the telecommunications networks that tie together the NII—are but one, very important part of that infrastructure. The NII includes networks, "information appliances" (e.g. TV's, computers, telephones) that attach to them, information that flows over the NII, and people who build, run, and use it. As part of the Administration's NII initiative, we are working closely with industry and Congress on each of these components and are making very good progress. It is important to realize however that parts of the information superhighway already exist and that it will continue to evolve—as Andy Grove, the CEO of Intel, has said, "There won't be a ribbon-cutting for the information highway."

QUESTION: 21. b) What will be the chief benefits for rural states?

I would argue that rural states will benefit even more than the rest of the country from the development of the NII. The NII will enable all Americans to have instant access to the information they want, whenever and wherever they want, at an affordable price. Teachers and students in rural schools will be able to tap into a digital Library of Congress and communicate with scientists, teachers, and other students around the country and around the world. Projects like the Big Sky Telegraph in Montana are already demonstrating the power of distance learning, which one day soon will be as commonplace as faxing is today.

By shrinking distance and time, the NII will enable small companies in rural areas to be more tightly integrated into the global economy. By giving people in rural areas new job opportunities, the NII will slow or even reverse the flow of people from rural areas to our cities, enabling Americans to enjoy a high standard of living wherever they choose to live. Already, millions of Americans telecommute to work using computer networks and fax machines.

QUESTION: 21. c) What are the appropriate roles for the federal government and the private sector in building and operating the superhighway? How do we insure that government does not perform functions that can just as easily be done by the private sector?

The private sector will own and operate the National Information Infrastructure. That said, there are a number of important roles for the Federal government in promoting the development of the NII. First, the Federal government has a key role to play in funding long-term research on the fundamental technologies needed for the NII. Federal R&D programs like the HPCC Program provide funding for risky, long-term research that industry has been unwilling or unable to fund because a single company cannot capture the benefits of such generic research. Wherever possible, the Federal government looks for private-sector partners to share the cost and ensure that technologies developed are rapidly transferred to the marketplace. Over the last four decades, the Federal government, especially DOD and NASA, has invested billions of dollars in this area—funding many of the breakthrough technologies that have made the NII possible (e.g. the Internet, UNIX, and the computer workstation). As a result, the U.S. leads the world in many areas of information technology. While industry provides the lion's share of R&D funding in this area, most industry R&D funding goes to short-term product development, which of course often relies upon technologies developed in government-funded long-term research programs.

The government must be an effective user of information technology. The Administration is committed to using computer and networking technology to make government user-friendly, on-line, and less costly. In addition, we are promoting the use of the NII in the non-profit sector by providing funding for pilot projects through programs like the Telecommunications and Information Infrastructure Applications Program at the National Telecommunications and Information Administration. Over 90 matching grants have been awarded to link schools, hospitals, and other non-profit organizations to the Internet.

Government also has an important role in protecting privacy, security, and intellectual property on the information highway and must have assured access to an "emergency lane" for national security and disaster response needs in times of emergency. The Administration has undertaken a number of initiatives in this area.

Lastly, and perhaps most important, the Federal government needs to overhaul outdated telecommunications regulations that stand in the way of the development and deployment of the NII. That is why we are pleased that the Senate Commerce Committee has recently reported out legislation to remove many of the barriers to competition in the telecommunications sector. We hope that one day soon "any company will be able to offer any service to any customer." If we can replace regulation with competition, then American consumers will enjoy more choice, lower prices, and higher quality in telephone, cable TV, and networking services. But we must have real competition and that is why the Administration is working with the Committee and others in the Senate to improve the legislation in order to ensure that consumers are protected from monopoly power and that incumbent providers are not able to block the entry of new competitors into the marketplace.

QUESTION: 21. d) What portion of the current federal R&D budget and the FY96 budget request is devoted to the "High Performance Computing and Communications Initiative"? What specific activities are supported by the HPCC funding?

Of $72.9 B in the proposed FY 1996 Federal R&D budget, $1.14 B (1.6%) is allocated to the High Performance Computing and Communications (HPCC) Program. Of the $72.7 B in the estimated Fiscal 1995 R&D budget, approximately $1.08 B (1.5%) is allocated to the HPCC Program.

A strong research program in communications and computers is essential for the economic health and national security of the United States. Both depend increasingly on the development and effective use of advanced information and telecommunications technologies. The Administration's budget request includes funds that will enable scientists and engineers in government labs, universities, and industry to continue their leading-edge research, which has given the U.S. a clear lead in key information technologies.

The High Performance Computing and Communications Program is on the brink of accomplishing two of its most ambitious goals: (1) a scalable computer capable of sustaining one trillion operations per second; and (2) development of a nationwide network capable of transmitting a billion bits per second. Both of these goals represent a factor of 1000 gain over what was possible three years ago when the program began.

The HPCC Program is a comprehensive, well-balanced program funding research in a wide range of promising areas. The five components of the FY 1996 Program are:

-High performance computing systems
-The National Research and Education Network
-Advanced Software Technology and Algorithms
-Basic research and human resources

-Information Infrastructure Technology and Applications

OSTP recently released the HPCC annual report, which presents a very detailed description of hundreds of exciting projects supported by the HPCC program. The report also indicates how one can use the Internet to get more details on these projects.

EPSCoR Program

QUESTION: 22. We appreciate OSTP's interest in the EPSCoR program and the report which you prepared. If I look at the Administration's budget request, however, I find that except in NSF we don't receive much support. The result is that Congress adds funds for EPSCoR each year only to see the budget drop back down outside NSF. Can OSTP do anything to help?

Questions No. 22 and 23 answered under Question No. 23.

QUESTION: 23. We are still having difficulties with coordination of the non-NSF EPSCoR programs. You prepared a report on the federal-wide effort, but coordination appears to remain a very difficult problem. Is there anything further that OSTP can do to help with coordination?

OSTP continues to support the primary purpose of EPSCoR to improve the quality of science and enhance the competitiveness for federal research funding of scientists in eligible states. Coordination of agency efforts continues through the EPSCoR Interagency Coordinating Committee (EICC), convened by its Executive Secretary at NSF. Agency representatives meet monthly to share perspectives and jointly address issues of common concern. There is a joint effort underway to develop appropriate ways to evaluate the EPSCoR programs. A Strategic Planning Guide is being written that will assist states in developing their state science and technology plans. This guide is expected to be disseminated by the fall. The agency representatives also are developing an interagency strategic planning document, which is likely to be available by late fall.

OSTP works closely with OMB and the other member departments and agencies of the National Science and Technology Council (NSTC) in developing budget priorities and principles and coordinating the research efforts of the federal government. Through the NSTC process, OSTP will encourage further attention to EPSCoR as an important component of our efforts to build and sustain the nation's research enterprise.

QUESTION: 24. You are working with the National Governors' Association and the Carnegie Commission on a Federal-State Technology Partnership. Do you have anyone from the EPSCoR states or the EPSCoR Foundation involved in this effort? Wouldn't it make sense to involve them since EPSCoR is at the core of S&T Development in the S&T states and it logically feeds into their activities?

The State-Federal Technology Partnership Task Force is a joint endeavor of the Carnegie Commission on Science, Technology and Government, National Governors' Association, National Conference of State Legislatures, and the American Society of Mechanical Engineers. The Task Force, although formed at the request of Dr. Gibbons, is independent of the federal government. Its membership of twenty, established externally of OSTP, consists of sitting governors, state legislators, and business and university leaders.

It is our understanding that the Task Force membership was formed with a consideration of including representation from rural states or states with less well established federal research support. Members of the Task Force from such states include: Governor Jim Geringer of Wyoming, Governor Ben Nelson of Nebraska, Dr. Pricilla Grew, Vice Chancellor for Research of the University of Nebraska-Lincoln, and State Senator David Kerr of Kansas. Advisors to the Task Force who are either involved with the EPSCoR program or from EPSCoR states include: Richard Bendis, President, Kansas Technology Enterprise Corp., John Ahlen, Director, Arkansas Technology Authority, and the leadership of the Science and Technology Council of the States, Jacques Koppel, Executive Director, Minnesota Technology, Inc. and Marsha Schachtel, Executive Assistant to the Secretary, Maryland Department of Economic Development.

The National Science and Technology Council (NSTC) has established an ad hoc working group to review current federal S&T programs that have significant state-federal cooperative efforts. The working group is working with the Task Force to identify potential opportunities for enhanced state-federal cooperation in S&T to advance national goals. Most EPSCoR agencies have representatives involved in the working group.

QUESTION: 25. It is my understanding that, in the President's FY96 request, the Department of Agriculture's EPSCoR program, which received $10 million in FY95, is zeroed out. Why was this done? Given the success of EPSCoR throughout the gov-

ernment, do you believe that defunding EPSCoR activities at the Agriculture Department is in the public interest?

What portion of the FY96 budget request for civilian R&D is aimed at agriculture and what federal activities are supported?

The USDA EPSCoR program never has appeared as a specific line item in the President's budget. Fiscal year 1996 is no exception. Reference to the USDA's EPSCoR program has appeared in the Senate appropriation language, where the USDA has been directed, since 1991, to allocate 10% of the National Research Initiative Competitive Grants Program (NRICGP) towards USDA EPSCoR.

The NRICGP USDA EPSCoR program has been highly successful. Not only does the USDA devote a higher percentage of funds towards EPSCoR than any other government agency, it is the second only to NSF in actual dollars spent on an EPSCoR program. Given the small size of NRICGP ($100 million), this strong commitment to the program is unparalleled.

The NRICGP USDA EPSCoR program is dedicated to increasing scientific expertise in areas of research critical to agriculture. The second programmatic goal is to increase the competitiveness of scientists and institutions in USDA EPSCoR states. To do this, the NRICGP supports applications from individual scientists to enhance their research capabilities through sabbatical leaves, to purchase needed research equipment, to collect preliminary data through seed grants, or to pursue more long-term research projects through standard strengthening awards.

The USDA NRICGP is committed to its EPSCoR program and will continue it even if specific appropriation language is not apparent.

QUESTIONS ASKED BY SENATOR PRESSLER AND ANSWERS THERETO BY DR. LANE

NSF BUDGET

QUESTION: The FY96 budget request for the National Science Foundation is $3.36 billion, a three percent increase over the FY95 level of $3.26 billion.

What was the reason for the increase and what additional activities, if any, will it support?

ANSWER: The Foundation's request for a three percent increase reflects a strong commitment by the Administration to NSF and to fundamental research and education. NSF's investments in research and education strengthen and help to secure the nation's capability to excel in science and engineering. As a principal supporter of fundamental research conducted at colleges and universities and of mathematics, science, and engineering education, NSF helps to provide the nation with both the base of advanced knowledge and the highly skilled workforce needed to pursue and capitalize on opportunities in science and technology.

In addition, NSF investments in science and engineering return real dividends with respect to economic growth. There is general consensus among economists and policy researchers that public investments in science and engineering yield very high rates of return.

QUESTION: What is the five-year funding profile of the NSF?

ANSWER: NSF's five-year funding profile as stated in the President's FY 1996 budget, is:

However, the Administration recently revised this profile, through the NPR2 process, to provide constant funding from FY 1996 to FY 2000.

ACADEMIC RESEARCH FACILITIES

QUESTION: I notice the FY96 budget request does not include funding to start a new interagency academic research facilities program. in addition, the request proposes rescinding $132 million in the current FY95 budget already appropriated for that specific purpose.

Do you agree that the U.S. has a $10 billion backlog of academic research facilities needs, and, if so, why was an interagency facilities program not funded in the FY96 budget request?

What federal strategies would you recommend to ensure our Nation's scientists have quality facilities to conduct quality research?

ANSWER: One estimate of the backlog in U.S. academic research facilities needs is approximately $8 billion. Current estimates, assuming that the size of universities remains at roughly current levels, range from $8 billion to $15 billion.

Of the $250 million appropriated for academic research infrastructure in FY 1995, $118.133 million was appropriated for NSF's existing Academic Research Infrastructure (ARI) Program, and $131.867 million was allocated for a new interagency infra-

structure program. The availability of these funds for an interagency program was contingent upon the President requesting at least $250 million for NSF in FY 1996 for academic research infrastructure activities.

Given the current constrained funding environment, it was necessary for NSF to make some difficult choices. Accordingly, the Foundation chose to maintain a balance among the Foundation's investments in research activities, education, and infrastructure support. The President's FY 1996 budget request for the NSF's existing ARI Program totals $100 million, which is $45 million, or 82 percent, higher than its FY 1995 request of $55 million. Since the Foundation cannot at this time make a long-term commitment to an interagency infrastructure program, we chose to propose this $131.867 million rescission.

In its report on NSF's Fiscal Year 1995 request, the Senate Appropriations Subcommittee also called on NSF to show leadership in developing an interagency approach to the problem of academic research infrastructure renewal. in response, the National Science and Technology Council (NSTC) Committee on Fundamental Science formed a Subcommittee on Research infrastructure in September 1994. The subcommittee includes representatives from a dozen Federal R&D agencies, as well as the Office of Science and Technology Policy and OMB. The subcommittee submitted a draft report this month on the needs of academic infrastructure and its importance to human resource development, and developed a five-year interagency strategy for infrastructure renewal contingent on available funding. The report will be considered by the full committee.

BALANCE BETWEEN BASIC AND APPLIED RESEARCH

QUESTION: There is a continuing debate about the proper balance between basic research and applied and "strategic" research at NSF. What are your views about the appropriate balance between basic and applied research and, what kind of balance is reflected in the FY96 budget request?

ANSWER: The proliferation of terms to describe research has added unneeded layers of confusion to an already complex topic. Much of the confusion stems from a desire to assign distinct, mutually exclusive definitions to activities that are inherently overlapping and integrated. Excellent research in strategic areas is not different from the traditional curiosity-driven or fundamental research that has produced many of our scientific breakthroughs as you suggest. The danger is that resources might be diverted to areas that presently offer little scientific opportunity, in the name of national priorities. We must prevent this.

Virtually all of the research funding provided by NSF is focused on unanswered questions in science and engineering with unpredictable outcomes. Yet this research is often simultaneously influenced or inspired by current problems and potential applications. Basic research in computational geometry, for example, shares a close relationship with many industrial challenges—such as virtual prototyping, virtual manufacturing, and networking of laboratories and factories.

The "Interdisciplinary Strategic Areas" discussed in NSF's FY 1996 budget request encourage these connections between the quest for new knowledge and the benefits that flow to society from advances in science and engineering. The seven areas NSF has identified are designed to build stronger links between research priorities and important social and economic challenges facing our nation—such as improving infrastructure investments and promoting lower cost, environmentally-compatible design and manufacturing processes. Although all research is inherently forward-looking, the strategic areas help to provide a sense of foresight and integration concerning the future needs of the nation.

For us, the notion of balance takes a different direction from the basic/applied dimension. NSF is unique among Federal agencies in having responsibility for the overall health of science and engineering across all disciplines. This means we must fund excellent research in subfields where the importance to the nation cannot be identified in advance, because we may be surprised by its contributions in the future. Thus we must make sure that there is appropriate balance, across scientific areas.

QUESTION: Does the new emphasis on strategic research (which supports national needs) in any way undermine the traditional commitment to the curiosity-driven research of individual researchers?

ANSWER: The preponderance of the research supported by the Foundation is in areas of clear importance to the nation. As a shorthand for this kind of research, we use the phrase "research in strategic areas". Our initiatives in these areas embody the essence of NSF's major goals, particularly the goal of "discovery, integration, dissemination and employment of new knowledge in service to society". The

emphasis on research in strategic areas is entirely consistent with our traditional commitment to fundamental research.

GLOBAL CHANGE RESEARCH PROGRAM

QUESTION: What is NSF's role in the major federal interagency science programs such as the Global Change Research Program? What are the main scientific questions that the global change research is intended to address? How might the agricultural community benefit from the results of global change research?

ANSWER: NSF plays a significant role in several interagency research programs. within interagency programs, NSF is generally responsible for supporting the fundamental research underpinning advances in strategic areas of importance to the nation.

NSF is one of a dozen agencies participating in the U.S. Global Change Research Program (USGCRP), an interagency effort that coordinates activities designed to produce a predictive understanding of the integrated Earth system and, as stated in the Global Change Research Act, provides "usable information" to policy makers. Within the USGCRP, NSF is responsible for maintaining the health of basic research in all areas of solid earth, atmospheric, ocean, polar, and social sciences. This basic research focuses on studies at regional and global scales; large-scale field programs; interpretation and use of remotely sensed data and geographic information systems; theoretical and laboratory research; research facilities support; and the development of numerical models, computer databases, and information and communication systems. The primary global change research emphasis at NSF has been the support of activities that advance fundamental understandings of the complex interactions among different facets of the Earth system. This includes studies of the impacts of biological and human systems on the physical systems of Earth, interactions among the different physical systems, and analyses of the consequences of physical system change on biota and people.

The scientific questions being addressed through NSF-supported global change research include the establishment of an integrated, comprehensive long-term history of the Earth system on a global scale; to improve our understanding of the physical, geological, chemical, biological, economic, and social processes that influence Earth system processes and trends on global and regional scales; and to develop integrated conceptual and predictive Earth system models.

More complete understanding of the dynamics that result in changes in climate around the globe have great significance for agricultural communities in all parts of the United States. The benefits of improved understanding of Earth-system dynamics are evident in advances made by agricultural leaders in Brazil, where better understanding of the forces that produce the El Nino-Southern Oscillation phenomenon and improved forecasts have greatly reduced decline in crop production during El Nino-associated droughts. The expansion of the relatively new Climate Variability and Predictability (CLIVAR) research program will provide comparable advances in knowledge and seasonal prediction capabilities for regions influenced by temperate oceans, including most agricultural regions of the United States.

Fundamental research on long-term climate changes also makes valuable contributions to agricultural activities in the United States. Global change research yields clearer understandings of changes in temperature, precipitation, and solar radiation, variables that have enormous impacts on the production of corn, grains, fruits, vegetables, and livestock. Advanced knowledge of climatic changes is especially important, because development of new hybrids and other advances needed to cope with changing conditions generally require development periods on the order of 10 to 15 years. Global change research also provides better understanding of factors that will affect water supplies, including the availability of water for irrigation and the consequences of changing seasonal precipitation patterns on non-point source pollution of surface and ground waters.

HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS PROGRAM

QUESTION: The FY96 budget request allocates $314 million to the High Performance Computing and Communications program which supports the building of the so-called information superhighway.

What activities are supported by the spending on high performance computing and communications?

ANSWER: NSF's High Performance Computing and Communications (HPCC) program is part of the Federal HPCC Program. The intent of the Federal program is to speed the pace of innovation in science and engineering, to improve U.S. ability

to investigate and understand fundamental problems in science and engineering, and to spur gains in U.S. productivity and industrial competitiveness through the development and use of high performance computing and networking technologies. To fulfill its role in the closely-coordinated Federal HPCC Program, the NSF HPCC Program supports a broad range of activities to improve the HPCC infrastructure, to advance the computational state-of-the-art for scientific and engineering research and technological applications, to advance the networking state-of-the-art for science and engineering research, to disseminate this knowledge to potential users, and to educate and train people in HPCC. Briefly, these activities fall into three broad categories: research, infrastructure, and education and training. One part of this initiative is explicitly directed toward the National Research and Education Network program, a precursor to and part of the networking commonly referred to as the information superhighway.

Fundamental research is supported in such areas as scaleable computing systems, mass storage, networking technologies, improved software tools, and improved algorithms. Infrastructure efforts, directed at the broad science and engineering community, make advanced computing and communications information infrastructure (via the very High Speed Network Service) available to the research and education community and demonstrate its usability to a larger segment of the society to solve information intensive problems and to advance education and research. Education and human resource activities create a cadre of researchers and technical personnel knowledgeable in and prepared to take advantage of new HPCC capabilities.

INFORMATION SUPERHIGHWAY

QUESTION: When will construction of the information superhighway be completed?

ANSWER: The information superhighway, like other communications systems, is an entity that will continue to grow and evolve as its existing capability becomes evident to the general community, and unexpected new uses are developed. As more people use the Internet and place more demands on its information carrying capacity, upgrades will be needed. Since the commercial sector is moving rapidly to make general purpose (i.e., "commodity ") level services available, direct Federal support for general purpose networking is being greatly reduced in 1995, and slated to end in 1999.

Federal support for research on cutting-edge high-bandwidth high-speed networking is continuing. A new experimental very high-speed backbone network service is scheduled to begin operation in 1995. This will initially connect the supercomputer centers supported by the Foundation to enable testing of new distributed applications, and exploration of potential problems and opportunities associated with high-speed network connectivity.

QUESTION: How will the information superhighway benefit citizens in our rural states and what are some of the possible applications that would be most relevant to the rural states?

ANSWER: Through the Internet, it is possible to access information resources from anywhere in the world. Limitations on access to specialized information resulting from location will be significantly reduced or, ultimately, removed. One of the goals of the Foundation's support of fundamental research is to enable development of improved information technology allowing facile access to even more diverse information sources. For example, NSF, ARPA and NASA have joined in a cross-agency research initiative on digital libraries. This program is aimed at generating new technologies and testbeds that will make books, video materials, speech and sound, databases, as well as other knowledge resources such as artifacts in museums or research collections widely available to and usable through the use of high speed networks. In effect, the vision is to make the Library of Congress to be as easily accessible to potential users in the western states as it is to those in the District of Columbia. One can readily visualize delivery of improved medical services, improved ability to consult with experts to analyze and deal with unexpected agricultural problems, and have simpler and less expensive access to specialized instrumentation and unique educational resources.

INDUSTRY SUPPORT FOR RESEARCH

QUESTION: The importance of industry participation in our federally supported research programs cannot be overstated. Industry involvement reduces costs to the taxpayer, promotes technology transfer to the private sector, and helps make federal research more relevant to industry needs and U.S. competitiveness.

What programs does NSF support to promote industry participation and technology transfer and, how successful have those programs been?

ANSWER: Partnerships and people are the key to knowledge transfer. In order to deliver the greatest return on its investment in creating new knowledge and developing intellectual capital, NSF is continuing to take leadership in fostering and catalyzing partnerships with industry, academe, and other communities.

Throughout its history NSF has exhibited leadership in forming new kinds of partnerships for supporting research and innovation. For example, in the 1970's, NSF pioneered such concepts as Industry/University Cooperative Research Centers (I/UCRCs). More than fifty such centers are currently in operation, carrying out research in a wide range of technologies. NSF's annual support for these centers ranges between $50,000 and $100,000 and, on average, is leveraged 11 times with industry and other sources.

The Small Business innovation Research (SBIR) Program is an NSF innovation of the 1970's. This government/private sector partnership has helped move numerous research developments to the marketplace by supporting research to prove the technical feasibility of an idea. The NSF Program served as a model for the SBIR Development Act of 1982, which established a national SBIR program.

By the 1980's, as increasingly swift and more sophisticated technological change facilitated and prompted cross-disciplinary research, NSF responded with new types of partnerships which integrated science, engineering, technology, and education. Among these were the Engineering Research Centers (ERCs), which are large and visible enough to influence academic culture and its reward structure. Over time, the ERCs have helped to include a systems-oriented focus in academic education and research, and served as a model for establishing similar centers in the U.S. and worldwide.

In the 1980's, the Science and Technology Centers (STC) Program, modeled partially on the ERC concept, was established to encourage university-based scientists and engineers to focus on research with long-term technological horizons and provide a mechanism to exploit opportunities where the complexity of the research challenges require the advantages of collaborative science-engineering relationships. They offer the research community a significant new mechanism to explore new areas of research, build bridges among disciplines, and explore better and more effective ways to educate students.

NSF established the Grants Opportunities for Academic Liaison with Industry (GOALI) Program to facilitate the exchange of university and industry personnel. This is accomplished by supporting a balanced spectrum of collaborative activities, ranging from the interaction with and contribution by the industrial partners, from visits to full-scale cooperative projects. Creative individuals are supported for proposals that will not only establish new working and long-term relationships, but provide innovative approaches to graduate and postdoctoral education. The importance of the initiative is underlined by the synergism resulting from the individual industry-university collaborative projects, the increased need of basic research to support high-tech industry, and the need to improve the education of students hired by industry.

Another recent program innovation is the Small Business Technology Transfer Research (STTR) program which addresses the development of existing university research results by small businesses. This is a critical problem in the United States, since foreign companies are often more effective than U.S. companies at developing commercial technologies from new ideas developed by U.S. researchers. STTR projects must be industry-led, but not less than 30% of research funding must—and up to 60% may—be devoted to university-based research and development efforts. This assures flexibility in determining the optimum sharing of responsibilities during the technology hand-off.

Recently, NSF has been emphasizing the support of fundamental research in areas of national interest. Research spans areas as diverse as civil infrastructure systems, manufacturing, biotechnology, and the environment. This research is fundamental in nature and permits individual researchers to pursue their own creative ideas but within a larger context of knowledge in service to society. University-industry collaborations are especially important in this context because they help make the essential knowledge transfer between the different sectors and better prepare students for careers in industry and government. Such cooperation brings many disciplines and backgrounds together to solve complex problems and can increase the potential for early application of the knowledge generated.

The primary similarity among these NSF programs is their concentration on increasing the interactions between university-based researchers and educators and private sector businesses. In general, these efforts have been very successful. For example, in 1994, the 18 ongoing ERCs had active partnerships with over 416 firms

and industrial consortia; these partnerships involved almost 400 joint projects. Over the ten year life of the program, the ERCs have produced 216 patents and 1,161 licenses for software and other developments. The I/UCRCs currently involve about 1,800 faculty and students who work with over 600 firms across the nation on projects highly relevant to industrial needs. These centers have spawned a wide range of changes in industrial processes and numerous advances that have resulted in commercially viable products and technologies. GAO evaluations of the SBIR program found that it has been generally successful in stimulating the development of new products and services, creating new jobs, and stimulating new areas of research.

Perhaps the greatest value of these efforts, however, is the cultural change they are fostering in academe and industry, which increasingly values the benefits and synergy of working together of linking knowledge, capabilities and facilities in ways that were rare before the existence of these programs.

QUESTIONS ASKED BY SENATOR BURNS AND ANSWERS THERETO BY DR. LANE

FUNDING PROJECTIONS FOR NSF

QUESTION: With the emphasis on federal deficit reduction, NASA and some other science programs are facing budget cuts. However, the FY96 budget request for the National Science foundation (NSF) is $3.36 billion, an increase of 3 percent over the current funding level. What factors contributed to NSF's request for a funding increase? What does the projected outyear funding profile for NSF look like?

ANSWER: The Foundation's request for a three percent increase reflects a strong commitment by the Administration to NSF and to fundamental research and education. NSF's investments in research and education strengthen and help to secure the nation's capability to excel in science and engineering. As a principal supporter of fundamental research conducted at colleges and universities and of mathematics, science, and engineering education, NSF helps to provide the nation with both the base of advanced knowledge and the highly skilled workforce needed to pursue and capitalize on opportunities in science and technology.

In addition, NSF investments in science and engineering return real dividends with respect to economic growth. There is general consensus among economists and policy researchers that public investments in science and engineering yield very high rates of return.

The five year funding profile for NSF, as stated in the President's FY 1996 Budget Request is:

National Science Foundation
Budget Authority FY 1996-FY 2000
(dollars in thousands)

FY 1996	FY 1997	FY 1998	FY 1999	FY 2000
$3,360,000	$3,259,200	$3,192,000	$3,124,800	$2,919,328

However, the Administration recently revised this profile, through the NPR2 process, to provide constant funding from FY 1996 to FY 2000.

ACADEMIC RESEARCH FACILITIES

QUESTION: No matter how good they are, scientists cannot perform quality research without adequate lab equipment and facilities to do the research. For that reason, the FY 1995 appropriation for NSF provided $132 million for the development of an Interagency infrastructure program, with release of those funds contingent on NSF's submission of a development plan. However, NSF elected to forgo the money and not initiate such a program.

Given the enormous scientific Infrastructure needs at the Nation's universities, estimated by some at over $10 billion, why would NSF elect not to take the federal funding for infrastructure?

What is NSF's current estimate of the cost of doing the necessary renovation and replacement of scientific infrastructure at our research universities?

If the federal government will not support a multiagency infrastructure program, what are some alternative approaches for dealing with the facilities problem?

ANSWER: Of the $250 million appropriated for academic research infrastructure in FY 1995, $118.133 million was appropriated for NSF's existing Academic Research Infrastructure (ARI) Program, and $131.867 million was allocated for a new interagency infrastructure program. The availability of these funds for an interagency program was contingent upon the President requesting at least $250 million for NSF in FY 1996 for academic research infrastructure activities.

Given the current constrained funding environment, it was necessary for NSF to make some difficult choices. Accordingly, the Foundation chose to maintain a balance among the Foundation's investments in research activities, education, and infrastructure support. The President's FY 1996 budget request for the NSF's existing ARI Program totals $100 million, which is $45 million, or 82 percent, higher than its FY 1995 request of $55 million. Since the Foundation cannot at this time make a long-term commitment to an interagency infrastructure program, we chose to propose this $131.867 million rescission.

NSF regards the Nation's academic research infrastructure as a key element in our efforts to maintain world leadership in science and engineering. Sophisticated research facilities and instrumentation are essential for the conduct of world-class

research and failure to renew or replace obsolete infrastructure will have long-term consequences. For this reason, NSF's 1995 Strategic Plan, "NSF in a Changing World" highlights the need to strengthen physical infrastructure as one of four "core strategies." NSF surveys of research facilities and instrumentation have documented needs that exceed $10 billion, assuming that there is no "right-sizing" of universities and that the size of universities remains roughly at current levels. A more recent NSF survey gives an estimate of $8 billion. Addressing these needs for renewal of physical infrastructure is critical not only to NSF's mission, but to the missions of many other Federal R&D agencies as well. This multi-billion dollar problem is therefore an interagency problem requiring an interagency solution, and also requires the cooperation of state, local, and private institutions.

In its report on NSF's Fiscal Year 1995 request, the Senate Appropriations Subcommittee also called on NSF to show leadership in developing an interagency approach to the problem of academic research infrastructure renewal. In response, the National Science and Technology Council (NSTC) Committee on Fundamental Science formed a Subcommittee on Research Infrastructure in September 1994. The subcommittee includes representatives from a dozen Federal R&D agencies, as well as the Office of Science and Technology Policy and OMB. The subcommittee submitted a draft report this month on the needs of academic infrastructure and its importance to human resource development, and developed a five-year interagency strategy for infrastructure renewal contingent on available funding. The report will be considered by the full committee.

Federal grant programs are only one component of a comprehensive solution to the infrastructure problem. NSF's Academic Research Infrastructure Program requires institutional cost sharing that leverages the Federal investment to a significant degree. Alternative approaches beyond direct Federal support would help universities, colleges, and other research organizations manage debt financing. These approaches include issuance of tax-free bonds, low interest loans, and loan guarantees. These approaches all force institutions to set priorities very carefully before assuming responsibility for debt financing, thereby helping to avoid ill-advised expansion. However, these mechanisms do not necessarily provide coordination of investment on a national level, thereby making it possible for institutions to create redundant and underutilized facilities.

BASIC RESEARCH VS STRATEGIC RESEARCH

QUESTION: Do you believe the FY96 budget request strikes the appropriate balance between basic research and strategic research, that is research targeted at specific National priorities? Do you believe the new emphasis on strategic research undercuts the traditional curiosity-driven research that has produced many of our scientific breakthroughs?

ANSWER: Research in strategic areas and basic research are not mutually exclusive categories. NSF support is almost entirely for basic research. Further, the preponderance of the research supported by the Foundation is in areas of clear importance to the nation. Thus "strategic" and "basic" are not either/or categories. NSF is unique among Federal agencies in having responsibility for the overall health of science and engineering across all scientific and engineering disciplines. Thus the balance we must strive for is between research in areas of obvious strategic importance to the nation, and research in other areas of science, whose contributions are not as easy to foresee. We think our FY96 budget does this.

Excellent research in strategic areas is not different from the traditional curiosity-driven or fundamental research that has produced many of our scientific breakthroughs as you suggest. The danger is that resources might be diverted to areas that presently offer little scientific opportunity, in the name of national priorities. We must prevent this.

U.S. INVESTMENT IN BASIC RESEARCH COMPARED TO OTHER COUNTRIES

QUESTION: How does our federal budget for basic research compare with that of other industrialized nations and how does our science policy compare with theirs?

ANSWER: Basic research expenditures totaled about $31 billion in the United States in 1994. German, French, and Japanese basic research expenditures combined total around 80% of the US expenditures. Basic research accounts for about 18% of US R&D expenditures. This compares with about 20% for Germany and France. Japan's ratio of basic research to total R&D is somewhat lower, at about 13%.

Most national science policies put a high value on the support of basic research. According to data released in the President's 1996 budget submission, basic research comprises about 20% of U.S. federal R&D spending in 1994,1995 and 1996. This compares with 28% of the federal R&D expenditures for basic research in Germany in the same period.

Basic research is viewed in most countries as a responsibility of the public sector. Approximately 85% of basic research in France is performed in the government and university sectors. Comparable figures for Germany and Japan are 77% and 58% respectively. About 62% of basic research in the U.S. is performed in the government and university sectors.

Most governments acknowledge the important role of basic research in the development of new technologies and industries, and support research in strategic areas such as biotechnology, new materials, microelectronics and information technologies, telecommunications and transportation. Both Japan and the European Union have emphasized basic research in strategic areas.

In addition to acknowledging that investments in basic research are key for future technological competitiveness, the science policies of most countries also acknowledge that human resource development is a key element for the future This means both training future scientists and engineers and developing a broad base of science and technology (S&T) understanding among their populations. Many countries also are increasingly putting emphasis on investing in basic research in areas of societal needs such as environmental and medical research.

Governments have generally maintained a commitment to science and technology and innovation even during recessions. They see investment in S&T as a means of overcoming economic difficulties. Many countries are facing budgetary pressures and are streamlining or restructuring R&D systems, including public/national laboratories. Most governments are also under increasing pressure to prioritize R&D and to evaluate the outputs and impacts of their expenditures for science and technology. Most nations are also trying to modernize their academic and national research facilities.

International cooperation and global networking are increasingly important in most national science policies, in part due to increased budgetary pressures in the face of increasing scientific opportunities; but also in recognition that partnerships are increasingly important in our global and integrated economy, and that international cooperation may be the only way some problems can be studied. Such S&T cooperation is seen as a valuable foreign policy instrument when dealing with developing countries as well as a possible entree for foreign trade and investment.

Information on these topics can be found in NSF's Science and Engineering Indicators-I 993, and the Organization for Economic Co-operation and Development's Science and Technology Policy Review and Outlook 1994.

INDUSTRY INFLUENCE ON NSF GOALS AND POLICIES

QUESTION: What role, if any, does U.S. Industry play in the development of NSF's goals and policies?

ANSWER: U.S. industry plays a significant role in the development of NSF's goals and policies. For example, the National Science Board, NSF's direction-setting body, has always enjoyed participation by members with industrial affiliations. Three of the 23 current members of the National Science Board and 25 of the 148 former Board members, including three who served as NSB chairmen within the last fifteen years, have had a primary affiliation with industry at the time of appointment..

Representatives from industry are also included on our advisory committees. For instance, in FY 1994, 34 of the 975 members of standing advisory committees were from industry. These committees are of three types: general advice committees to provide input to the Foundation's long-range plans, goals, performance and policies; proposal review panels consisting of specialists who review proposals in specific scientific areas; and special purpose committees such as the President's Committee on the National Medal of Science and the Committee on Equal Opportunities in Science and Engineering.

INFORMATION SUPERHIGHWAY

QUESTION: What Is NSF Doing to promote and support the development of the "information superhighway"? What do you believe Is the appropriate role for the federal government In the development and building of the superhighway?

ANSWER: NSF is promoting and supporting the development of the "information superhighway" by continuing to support the development of new networking technologies, new bandwidth-intensive network applications, the connection of the re-

search and education community to the network, and the fundamental research in networking and communications to ensure the continued progress in these areas.

NSF believes that an appropriate role for the federal government is to pursue this same strategy in the future for the following reasons:

It resulted in the dramatic evolution from a special purpose network serving a small number of research scientists and engineers into the Internet which today serves millions of users from all walks of life.

It has provided the private sector with an understanding of the potential of commercial commodity network services, and stimulated the growth of a new multibillion dollar industry.

It builds on NSF's role as a supporter of leading-edge network research, allows for experimental testing and trial implementation in support of research and education, and allows the private sector to move in rapidly and effectively to competitively develop commodity services independent of governmental funding.

QUESTION: The applications of the information superhighway in areas like telemedicine, telecommuting, and long distance learning will have an enormous impact in rural states like my state of Montana. What is your view on how the Information superhighway will change the way we live, work and learn?

ANSWER: The information superhighway offers significant possibilities for improving the way people in Montana and other rural states live, work, and learn. Through the Internet, it is possible to access information resources from anywhere in the world. Limitations on access to specialized information resulting from location will be significantly reduced or, ultimately, removed. One of the goals of the Foundation's support of fundamental research is to enable development of improved information technology allowing facile access to even more diverse information sources. For example, NSF, ARPA and NASA have joined in a cross-agency research initiative on digital libraries. This program is aimed at generating new technologies and testbeds that will make books, video materials, speech and sound, databases, as well as other knowledge resources such as artifacts in museums or research collections widely available to and usable through the use of high speed networks. in effect, the vision is to make the Library of Congress to be as easily accessible to potential users in the western states as it is to those in the District of Columbia. One can readily visualize delivery of improved medical services, improved ability to consult with experts to analyze and deal with unexpected agricultural problems, and have simpler and less expensive access to specialized instrumentation and unique educational resources.

NETWORK SECURITY

QUESTION: The increasing reliance on computers by our government, businesses, colleges, banks, and other Institutions have made the Nation extremely vulnerable to attacks by "hackers". According to recent reports, these hackers pose an increasing risk to our national and economic security.

QUESTION: How serious is the problem of computer security?

ANSWER: Recent events have provided evidence that computer security is a very serious problem. As the user community becomes increasingly aware of the risks, better methods have become available to secure systems, detect attacks, and trace unauthorized access. Increasingly more sophisticated, such measures are implemented more routinely and widely across the Internet as well as on local networks.

QUESTION: Is it a problem within NSF and its computer network?

ANSWER: Assuring the security of the Foundation's information systems is a high priority within the agency. Fortunately, we have not been the victim of any significant security problems.

QUESTION: What steps are being taken by NSF and other agencies to address the problem of computer security?

ANSWER: The question of computer and network security transcends any single agency, and cooperative efforts are essential. One example of interagency cooperation in security is the work on networking being carried out by the Federal Networking Council which established a security working group to develop an overall security framework for government agencies. That group has made its preliminary report, which will soon be put before the Internet community for comments and suggestions.

In addition, security is also a high priority for certain NSF grantees which have special problems resulting from their responsibilities. For example, the NSF Supercomputer Centers have a very active network security group whose goal is to allow broader national access to these advanced facilities, while improving security and maintaining ease of use.

At the Foundation, we have installed equipment on our network which minimizes the likelihood of security problems and we routinely use software which scans desktop computers and network servers for viruses. All access to central systems is password protected and we are evaluating systems designed to minimize the likelihood of having passwords compromised.

With the increase in the use of the Internet and other vehicles for interactions between outside sources and internal NSF systems, we are implementing a "firewall" to ensure that only valid operations access internal network services and data.

CIVIL INFRASTRUCTURE

QUESTION: In 1993, the science Subcommittee held a hearing on the application of federal R&D to Improve our civil infrastructure, including bridges, highways, and buildings. I note that the FY 1996 budget request for NSF specifically allocates $57 million for civil infrastructure research.

What specific activities will NSF's civil infrastructure funding support?

ANSWER: NSF will contribute to the process of intelligent renewal through the support of fundamental research focusing on the scientific, engineering, and educational developments needed to sustain civil infrastructure systems. The purpose of this research is to develop new knowledge and innovative approaches and methods through projects involving engineers, economists, and physical, mathematical, materials, and social scientists.

This strategy focuses on the optimal performance of systems, in addition to understanding the individual components. Focusing on the performance of individual components in separate systems results in incremental improvement in some areas but does not substantially improve the performance of the overall system. The new strategy emphasizes systems integration at all levels and specifically addresses the need to develop new scientific and engineering knowledge in the following four key areas, which were identified through consultation with the relevant research and practitioner communities.

Deterioration Science is concerned with the mechanisms controlling how materials and systems break down and wear out during normal use and when subjected to natural and technological hazards. Research is needed to improve our understanding of deterioration processes, so that we can design, build, and maintain infrastructure systems that are more durable, safe, and environmentally sound.

Assessment Technology addresses the need to assess the condition of our Civil Infrastructure Systems. We need to be able to determine the level of performance, operational safety, reliability, and environmental acceptability of components and systems. The ultimate objective is to develop sensing, monitoring, and controlling systems for the effective management of our infrastructure systems.

Renewal Engineering deals with the development of materials and methods to extend and enhance the useful life of civil infrastructure systems. Research should focus on new approaches for integrated planning, information management, design, construction, installation, maintenance, repair, retrofit, recycling, demolition, and disposal. The research outcome must fit the economics of real-world situations, and must consider the infrastructure life span in both normal and hazardous conditions.

Institutional Effectiveness and Productivity pursues effective decision making on civil infrastructure systems. New approaches are needed for decision process and optimization modeling, which involve economists, engineers, mathematical scientists, natural scientists, and social scientists. These models require both qualitative and quantitative input. The impact of civil infrastructure systems investments or regulation on national, regional, and local productivity, and on the economic and social well-being of the public also needs to be evaluated.

QUESTION: What Improvements In building and maintenance technologies are foreseen as a result of the R&D on civil infrastructure?

ANSWER: We know that constructed infrastructure facilities are deteriorating and require evaluation, repair, retrofit, and replacement for safety and longer life. We expect that civil infrastructure research will lead to structures and facilities that are safer, more economical, easy to maintain and retrofit, have longer effective life spans, are less energy intensive, and more compatible with the environment.

One example is research on advanced materials for structural, communication, energy, and transportation applications. Ongoing activities include research on the design and processing of composite materials with improved toughness and wear resistance, new coatings for materials that impart greater resistance to environmental failure, and improved understanding through modeling and computation of the processes leading to materials degradation. For example, many different forms of the fiber reinforced plastics are being studied to determine strength, corrosion resistance, and life cycle costs. Future infrastructure systems and facilities may be con-

structed of these materials so that they will last longer, require less maintenance, and be competitive in cost to conventional materials on a life cycle basis.

In another example, research is aimed at applying high technology instrumentation, now in use in the aerospace industry, for real-time sensing to monitor performance changes in infrastructure systems. For example, optical fibers are embedded in concrete for sensing stress, loads, and failure. Such safety and reliability assessments will point out the weak links in a complex, constructed facility so that corrections may be made before serious failures occur.

QUESTION: Would you share with the Subcommittee any recent breakthrough developments generated by the Infrastructure program.

ANSWER: While breakthrough developments occur in this area, more typically the research leads to incremental, continuous improvement in infrastructure materials, systems, and methodologies. One reason for this is that implementation of Civil Infrastructure Systems technologies often require substantial institutional and regulatory changes. For example, NSF was a major supporter of early developments in Load and Resistance Factor (LRFD) design approaches for CIS structures—an approach which is still moving into various codes/manuals of practice from steel, concrete, wood and so on, resulting in leaner, more efficient, and safer designs.

Because of its focus on continuous improvement, the impact of infrastructure research should be measured over time. Two examples where sustained NSF support has substantially impacted the Nation's infrastructure are:

- NSF support of earthquake engineering research has helped establish the designs and building codes for present day earthquake resistant buildings. Focusing on the response of soils and structures to earthquake loads, research results have contributed to enhanced seismic safety in areas at risk throughout the country. The recent Loma Prieta and Northridge earthquakes demonstrate how far the U.S. has come, in comparison to many other countries, in developing knowledge and techniques to counteract such events and in more closely linking the efforts of researchers and practitioners. For example, recent events of similar magnitude that occurred in Mexico, Armenia, and Japan took a far greater toll in lives than did the U.S. earthquakes.
- Since the 1960s, NSF has funded fundamental research on fracture mechanics and nondestructive evaluation methods. This has led to dramatic increases in the ability to predict causes of failures in materials, which has resulted in improved buildings, airplanes and automobile safety and extended lifetimes of such structures. in addition, improvements in predictive modeling for materials and structures has led to less conservative, less costly and more reliable designs for structures and facilities.

QUESTION: What is the government-wide budget request for R&D that is targeted at civil infrastructure and how does it compare with the funding levels in recent years?

ANSWER: Civil infrastructure R&D is not well defined in the Federal budget. To the best of our knowledge, the best approximation of a government-wide request for this area may be an estimate of Federal Construction R&D which was recently developed by the NSTC Subcommittee on Construction and Building, which totaled more than $140 million for FY 1995.

BIOLOGY RESEARCH PRIORITIES

QUESTION: Last March, our Subcommittee heard testimony about the applications of biotechnology in agriculture and other areas. What are the main priority areas for NSF-supported research In biology? How much of the biological research Is devoted to potential agricultural applications? What are some of the more promising agricultural applications within that research?

ANSWER: NSF is the major source of funding for competitive, merit reviewed research at the Nation's universities and colleges. NSF also plays a key role in building the fundamental knowledge base required for major advances in areas of strategic importance, in particular for biotechnology in areas other than health; and in research on the environment and global change. NSF plays a unique role in support of research at the frontiers of biological knowledge. In some areas such as fundamental research in plant biology and environmental biology including biodiversity, the Foundation plays an essential role.

For FY 1996 three emerging opportunities have been identified. First, with international partners, we will embark on a major effort to sequence the entire genome of the model higher plant, Arabidopsis thaliana. Knowledge of plant genomes is important for understanding all aspects of plant growth and development, the mechanisms by which plants respond to the environment and defend themselves against pests and pathogens; all of which have potential agricultural implications/applica-

tions. Because the genomes of agriculturally important crop plants tend to be large and complex, identification of the flowering plant, Arabidopsis thaliana as a model has been a major advance. Arabidopsis has a small genome, a short life cycle, and is small enough that large numbers of plants can be grown in a small space. NSF has played the leading role in establishing this organism as a model and is the lead agency in an international genome project which is now on the threshold of a major international effort to sequence the Arabidopsis genome. Two additional emerging opportunities are, fundamental research to build the knowledge base for ecosystem restoration and bioremediation, and research in computational and theoretical biology to enable development of theories that can provide road maps to understanding complex biological systems.

Approximately 30% of NSF's support for biological research is devoted to research with potential agricultural applications. This is primarily fundamental research on plants but also includes research on insects and some aspects of animal biology.

A number of promising agricultural applications exist. For example:

• Understanding the mechanisms by which plants regulate their uptake of salts can lead to development of plants that are tolerant of saline soils and resistant to metal pollutants.

• Understanding the fundamental mechanisms by which plant hormones control growth and development offer the ability to develop new crop plants with more economically desirable features.

• Understanding the basic mechanisms by which plants defend themselves from pests and pathogens can lead to pest and disease resistant plants.

Enhanced knowledge of plant and microbial metabolism can lead not only to new products but to new uses for agricultural products. In addition, NSF-supported research on insects and fish will have other applications in agriculture and aquaculture. For example, understanding the mechanisms by which insects such as grasshoppers resist their natural pathogens will contribute to our ability to use rational approaches to control insect pests.

FY 1996 EPSCoR ACTIVITIES

QUESTION: As we try to reduce the deficit, we have an obligation to make the federal R&D budget more relevant to the tax payers who pay for It In my view, the EPSCoR program helps to do just that It enables research Institutions In rural states like Montana and South Dakota to participate in NSF's science programs in a way that was not possible prior to the program.

What activities are supported In the FY 96 budget request of $36 million for EPSCoR?

ANSWER: The FY 1996 EPSCoR budget request is $35.9 million. Of this amount approximately $28.5 million will support Systemic Improvement cooperative agreements. In addition, it is anticipated that approximately $3.5 million will fund Experimental Systemic initiative (ESI) grants of up to $500,000 per state. In order to mainstream EPSCoR researchers into the Foundation's regular research and education programs, EPSCoR will provide about $2 million to jointly fund grant applications from EPSCoR institutions with other NSF divisions. In FY 1995, it is anticipated that approximately $1.5 million will support Small Business Innovation Research (SBIR) and other Foundation-wide programs with outreach to the states. The remaining $400,000 provides for program support, technical assistance to the EPSCoR states, merit review, and program monitoring, reporting and coordination.

QUESTION: Which states are currently in the EPSCoR program?

ANSWER: Eighteen states and the Commonwealth of Puerto Rico are currently eligible to participate in NSF's EPSCoR program. The states are: Alabama, Arkansas, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, North Dakota, Oklahoma, South Carolina, South Dakota, Vermont, West Virginia, and Wyoming.

QUESTION: How many other federal R&D agencies now have EPSCoR programs?

ANSWER: The Department of Defense, Department of Energy, Environmental Protection Agency, National Aeronautics and Space Administration, National Institutes of Health, National Science Foundation, and the U.S. Department of Agriculture currently have EPSCoR or EPSCoR-like programs that address the need to increase research competitiveness among less competitive states, institutions, or investigators.

QUESTION: How would you evaluate the EPSCoR program and how successful has it been In enabling institutions in EPSCoR states to become more effective in competing for federal research grants?

ANSWER: A comprehensive evaluation of the EPSCoR program, through a third party, is currently under way and will be conducted in two phases: (1) a six-month

study of the program's educational impacts to be completed by the end of this calendar year, and (2) a full evaluation to be completed by the end of FY 1996.

The objectives of the evaluation are to: (1) provide summary data on impacts that account for the diversity of program activities embedded in various university cultures; (2) cover both institutional and R&D outcomes in terms of building research capability; (3) include information about the effectiveness of intervention strategies and their possible replication at other sites; (4) produce results that are useful both to NSF and the states, given the evaluation design developed by the contractor to analyze the program as a complex experiment; and (5) communicate results to specialist and nonspecialist audiences alike.

The EPSCoR database and case studies will be used to illuminate the program's activities and successes from the perspectives of participant faculty, students, administrators, and state policymakers. Design of the evaluation has had the benefit of discussion with the EPSCoR program officers and representatives of EPSCoR states.

ADVANCED TECHNOLOGY PROGRAM

QUESTION: Given the success of EPSCoR at NSF and other agencies, do you believe that the process for awarding Advanced Technology Program grants and similar grants should be required to stress fairness in the geographical distribution of the awards?

ANSWER: NSF grant programs target specific research needs and seek to achieve a variety of goals and purposes. These programs are often designed differently using separate criteria for eligibility. At NSF we believe that all our programs should stress fairness and seek the very best outcomes available given their program goals. The goal of EPSCoR is explicitly to build scientific research capacity in states that have had difficulty in competing successfully for federal funding for basic research. Other federal research programs may have different objectives.

EPSCoR

QUESTION: As you know, research results do not occur overnight You fund many of your science and engineering centers programs for up to 11 years. How can we move some of the more successful EPSCoR clusters to the next level to compete for centers, and give them the resources and time that they need?

ANSWER: The current three- to five-year EPSCoR awards are designed to stimulate improvements in the R&D infrastructure that will allow EPSCoR research groups to become more competitive for the NSF's regular R&D funding programs, including its center programs. There are some notable successes, for instance, NSF is currently funding Engineering Research Centers at two of the EPSCoR states: Mississippi State University is doing research in computational field simulation and Montana State University has a center performing research in biofilm engineering. In addition, NSF is funding a Science and Technology Center at the University of Oklahoma to perform research on the analysis and prediction of storms.

In addition, EPSCoR co-funds with the Foundation's disciplinary research programs, proposals submitted by EPSCoR researchers. in FY 1995 EPSCoR will provide approximately $2 million to co-fund proposals from EPSCoR investigators with the regular NSF research divisions, including co-funding of a Materials Research Science and Engineering Center at the University of Alabama-Tuscaloosa

K-12 EDUCATION

QUESTION: What are some of the NSF programs focused on K through 12 education? How effective are our K through 12 educational systems in teaching math and science and what are some of the strengths and weaknesses of the U.S. system? How does the U.S. system compare with the approaches of other countries such as Japan?

ANSWER: NSF funds programs that support local and statewide systemic reform of science and mathematics education, the professional development of teachers, the creation of curriculum and instructional materials, the provision of informal learning opportunities, and hands-on learning experiences for children.

Overall, students are scoring higher today on a variety of measures of science and mathematics achievement than in 1982 despite the fact that the student population has become more racially and ethnically diverse. Some of the gaps in achievement scores between students of different races and ethnicity have narrowed. The gap between male and female average achievement in science has narrowed, while the gap in mathematics has almost entirely disappeared. The National Assessment of Education Progress conducted in 40 states in 1992 has shown that great differences are

found throughout the country that are not associated with ethnic origin. For example, white students in the north central region attain scores as high as those of Korea, while white students in Mississippi and Louisiana score far below most countries. These regional disparities are no doubt due to economic conditions as well as resources allocated to public school systems. Nonetheless, the overall performance in mathematics and science has increased over the past several years.

When compared with other countries, the achievement of U.S. students in science and mathematics lags several other countries that participated in the most recent comparative study (1992). Average mathematics achievement scores of U.S. nine year olds are well below those of students in Korea, Taiwan, and Hungary, for example. In science, U.S. nine year-olds scored, on average, about as well as nine year-olds in any country that participated in the study. Thirteen year-old students from the U.S. scored substantially below students from these and other countries in both science and mathematics. A new study in progress of approaches used in classrooms of elementary and secondary schools in 48 countries should help answer questions raised about the strengths and weaknesses of the U.S. system. As regards weaknesses in the U.S. system, preliminary evidence shows that the U.S. curriculum is much broader than in other countries and that U.S. teachers struggle to present adequately to their students the required wide variety of topics. The new study includes detailed investigation of the Japanese and German systems in particular and will reveal how those systems have been able to teach all students high levels of mathematics and science. Results from this study will be available in 1996.

Trends in U.S. student course taking and instruction are similar to trends in achievement. While enrollment in science and mathematics high school courses has increased over the past decade—with little difference in the course-taking patterns of males and females—fewer students from minority groups take advanced courses in science and mathematics than white students. And, despite the increases in enrollment, the number of students completing four full years of science and mathematics is still low. At the elementary level, the amount of class time devoted to science and mathematics has increased since the late 1970s.

Between 1986 and 1993 the proportion of mathematics teachers who have taken advanced level courses in mathematics increased, although teachers who teach predominantly minority students continue to be less well prepared than those who teach few minority students. The level of science preparation of science teachers has remained relatively constant.

Despite strong recommendations from the National Academy of Sciences and the National Council of Mathematics Teachers for hands-on approaches to science and mathematics instruction, high school teachers rely heavily on lecture, spending about 20 percent of science class time and less than 10 percent of mathematics class time on hands-on activities. By contrast, teachers at the elementary school level spend about 25 percent of class time on hands-on activities.

Overall, the U.S. education system does not serve all students equally, with the resources (e.g., materials and computers) and opportunities to teach and learn most limited in large urban and rural economically disadvantaged school districts. Nonetheless, the local, state, urban and rural systemic reform programs of NSF taken in combination with the available model instructional materials and standards-based mathematics and science curricula offer our best hope of achieving substantial improvement in the performance of 1(1 U.S. K-1 2 students.

ACADEMIC RESEARCH FACILITIES

QUESTION: Some have estimated that it would cost $10 billion over ten years to satisfy the Nation's academic research facilities needs. As a first step to address this problem, last year, Congress appropriated $250 million in FY95 for the NSF facilities and instrumentation program. However, $132 million of that amount was automatically rescinded because the Administration did not request the money in the FY96 budget request

What Is your assessment of the Nation's academic research facilities problem?

Why did the Clinton administration not request the additional $132 million for facilities and Initiate a program for a multiagency strategy to address the facilities problem?

Has the Administration developed any strategy or plan to deal with our deteriorating academic research Infrastructure?

ANSWER: NSF regards the Nation's academic research infrastructure as a key element in our efforts to maintain world leadership in science and engineering. Sophisticated research facilities and instrumentation are essential for the conduct of world-class research and failure to renew or replace obsolete infrastructure will have long-term consequences. For this reason, NSF's 1995 Strategic Plan, "NSF in

a Changing World" highlights the need to strengthen physical infrastructure as one of four "core strategies." Recent NSF surveys of research facilities and instrumentation have documented needs that exceed $10 billion. The latest survey suggested a "need" of $8 billion, assuming that no "right-sizing" of universities occurs. Addressing these needs for renewal of physical infrastructure is critical not only to NSF's mission, but to the missions of many other Federal R&D agencies as well. This multi-billion dollar problem is therefore an interagency problem requiring an interagency solution.

Of the $250 million appropriated for academic research infrastructure in FY 1995, $118.133 million was appropriated for NSF's existing Academic Research Infrastructure (ARI) Program, and $131.867 million was allocated for a new interagency infrastructure program. The availability of these funds for an interagency program was contingent upon the President requesting at least $250 million for NSF in FY 1996 for academic research infrastructure activities.

Given the current constrained funding environment, it was necessary for NSF to make some difficult choices. Accordingly, the Foundation chose to maintain a balance among the Foundation's investments in research activities, education, and infrastructure support. The President's FY 1996 budget request for the NSF's existing ARI Program totals $100 million, which is $45 million, or 82 percent, higher than its FY 1995 request of $55 million. Since the Foundation cannot at this time make a long-term commitment to an interagency infrastructure program, we chose to propose this $131.867 million rescission.

In its report on NSF's Fiscal Year 1995 request, the Senate Appropriations Subcommittee also called on NSF to show leadership in developing an interagency approach to the problem of academic research infrastructure renewal. in response, the National Science and Technology Council (NSTC) Committee on Fundamental Science formed a Subcommittee on Research Infrastructure in September 1994. The subcommittee includes representatives from a dozen Federal R&D agencies, as well as the Office of Science and Technology Policy and OMB. The subcommittee submitted a draft report this month on the needs of academic infrastructure and its importance to human resource development, and developed a five-year interagency strategy for infrastructure renewal contingent on available funding. The report will be considered by the full committee at their next meeting.

○

89-788 - 95 (160)

BOSTON PUBLIC LIBRARY
3 9999 05577 184 2

ISBN 0-16-047741-7

9 780160 477416 90000